

2 of 3

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A PROTOTYPE

CIVIL DEFENSE MANUAL

FOR

RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES

SECOND EDITION

VOLUME II - DECONTAMINATION OPERATIONS

BY

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ABSTRACT

This book comprises Volume II of the two volume Prototype Civil Defense Manual for Radiological Decontamination of Municipalities. Volume I of the set, Decontamination Planning, contains organizational, planning, and analytical information and is intended for use by Municipal and Zone Planners. Volume II, Decontamination Operations, is written for Zone Decontamination Leaders and Decontamination Team captains. It will be of value also, however, to Planners and others interested in Radiological Recovery.

Volume II contains practical, operational information on the decontamination of radioactive fallout. It discusses the types of surfaces which will be encountered, the methods best suited to their decontamination, and the special considerations required by cold weather. It describes the three basic principles of fallout decontamination; cleaning the surface, removing the surface, and covering the surface. The various methods for achieving decontamination are categorized as wet or dry methods, and are discussed individually in detail. Team make-ups, equipment requirements, and operational procedures are covered. The pages devoted to each method are organized as separate, specialized Decontamination Team operation handbooks.

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TABLE OF CONTENTS

ABSTRACT

LIST OF FIGURES

GLOSSARY (See Volume I)

1. OPERATIONAL PRINCIPLES OF RADIOLOGICAL DECONTAMINATION

- 1.1 Nature of Radiological Contamination
- 1.2 Scope of the Manual
- 1.3 Experimental Background
- 1.4 Fallout Distribution on Surface
- 1.5 Basic Types of Surfaces to be Decontaminated
- 1.6 Principles of Decontamination
- 1.7 Decontamination Teams
- 1.8 Methods of Decontamination
 - 1.8.1 Wet Methods
 - 1.8.2 Dry Methods
- 1.9 Condition of Equipment
 - 1.9.1 Operation of Equipment
 - 1.9.2 Maintenance of Equipment
 - 1.9.3 Supply Requirements
- 1.10 Protection and Decontamination of Team Members
- 1.11 Decontamination of Equipment
- 1.12 Modifications to Available Equipment for Decontamination
- 1.13 Improvised Decontamination Methods and Equipment

2. DECONTAMINATION OF STRUCTURES

- 2.1 Scope
- 2.2 Roof Area
- 2.3 Building Height
- 2.4 Climatic Conditions - Protection of Team Members
- 2.5 Roof Features
- 2.6 Classification of Roof Slopes
- 2.7 Flat Surfaces
 - 2.7.1 Decontamination of Flat Surface
 - 2.7.1.1 Tar and Gravel Roofs
 - 2.7.1.2 Promenade Tile Surface
 - 2.7.1.3 Rool Roofing
 - 2.7.1.4 Exposed Concrete or Macadam

2.8 Low Slopes (Slopes 1-on-12 to 3-on-12)

- 2.8.1 Asphalt Shingles**
- 2.8.2 Wood Shingles**
- 2.8.3 Slate Roof**
- 2.8.4 Clay Tile Roof**
- 2.8.5 Asbestos Shingles**
- 2.8.6 Sheet Metal and Corrugated Roofs**
- 2.8.7 Tar and Gravel Roofs**
- 2.8.8 Roll-Roofing**

2.9 Steep-Slope Roofs

- 2.9.1 Materials used in Steep-Slope Roofs**
- 2.9.2 Use of Lobbing to Decontaminate Steep Slopes**

2.10 Special Configurations

3. DECONTAMINATION OF PAVED AREAS

3.1 Scope

3.2 General Characteristics of Paved Areas

3.2.1 Drainage

3.2.2 Slope

3.2.2.1 Effect of Slope on Wet Decontamination

3.2.2.2 Effect of Slope on Dry Decontamination

3.2.3 Crown

3.2.4 Size of Paved Areas

3.2.5 Surface Condition

3.2.6 Obstructions

3.2.7 Areas Bordering Pavement

3.3 Equipment

3.4 Classification of Paved Areas

3.4.1 Portland Cement Concrete

3.4.2 Bituminous Materials

3.4.3 Brick and Stone Block Pavements

3.5 Selection of Method of Decontamination

4. DECONTAMINATION OF NATURAL AREAS

4.1 Scope

4.1.1 Decontamination Methods for Natural Areas

4.1.2 Factors Affecting Decontamination

4.2 Concepts of Decontamination of Natural Areas

4.2.1 Picking-Up the Surface

4.2.2 Pushing-Away the Surface

4.2.3 Turning-Under the Surface

4.2.4 Covering the Surface

4.3 Characteristics of Natural Areas

4.3.1 Slope

4.3.2 Vegetation

4.3.3 Earth Composition

4.3.3.1 Non-cohesive Soils

4.3.3.2 Cohesive Soils

4.3.3.3 Soils Containing Boulders

4.3.3.4 Filled Land

4.3.3.5 Exposed Rock Formations

4.3.4 Moisture Content and Climate

4.4 Selection of Method of Decontamination

5. COLD WEATHER DECONTAMINATION

5.1 Cold Weather in the United States

5.2 The Effect of Cold Weather on Decontamination

5.3 Cold Weather Equipment Care

5.4 Weather Data

5.4.1 Ice

5.5 Cold Weather Decontamination Methods

5.5.1 Condition 1 - Loose Fallout Lying on a Hard Frozen Surface

5.5.2 Condition 2 - Fallout Encases in a Layer of Ice

5.5.3 Condition 3 - Loose Fallout on a Hard Frozen Surface, Covered by a Layer of Snow

5.5.4 Condition 4 - Fallout Particles Entrapped in Ice, Covered by a Layer of Snow

5.5.5 Condition 5 - Fallout Particles Intermixed with Snow

5.6 Roofs of Structures

5.7 Selection of Decontamination Method

6. WET DECONTAMINATION METHODS

6.1 Scope

6.2 Principles of Wet Decontamination

6.3 Manual and Motorized Wet Methods

SPECIFICATION SHEETS

Firehosing Team

Motorized Steet Flusher

7. DRY DECONTAMINATION METHODS

7.1 Scope

7.2 Principles of Dry Decontamination

7.3 Dry Methods Included in This Manual

7.4 Surface Cleaning Methods

7.5 Surface Removal and Covering Methods

SPECIFICATION SHEETS

Manual Sweeping

Mechanical Sweeper

Vacuum Sweeper

Hand Shoveling

Motor Scraper

Motor Grader

Bulldozer

Plowing

Snow Plowing

LIST OF FIGURES

- 2-A Large Roof Areas Require Extended Hose Runs
- 2-B Roof Slopes
- 2-C Roof Obstructions Prevent Drainage Flow
- 2-D Typical Low-Slope Roofs
- 2-E Example of Steep-Slope Roofs
- 2-F Special Roof Configurations Presenting Decontamination Problems
- 3-A Types of Drainage for Paved Areas
- 3-B Paved Roads and Walkways Change in Both Slope and Direction
- 3-C Low Spots or Depressions May Collect Water and Fallout Particles
- 3-D Particle Build-up in Wet Decontamination
- 3-E Table - Decontamination Methods Applicable to Various Types of Paved Surfaces
- 4-A Problems of Natural Area Decontamination
- 4-B Sod Removal
- 4-C Pushing Away the Surface
- 4-D Plowed Earth Provides Oblique Angle Shielding
- 4-E Filling Over Fallout Particles with Clean Soil Provides Shielding From Radiation
- 4-F Decontamination Methods for Various Soil Conditions
- 5-A Cold Weather in the United States
- 5-B Summary of Cold Weather Decontamination Methods
- 6-A Firehosing
- 6-B Firehosing Precautions
- 6-C Firehosing Tar and Gravel Roofs
- 6-D Firehosing Roof Surfaces Other than Tan and Gravel
- 6-E Decontamination Team Lobbing
- 6-F Firehosing Pavements
- 6-G Conventional Street Flusher
- 6-H Conventional Street Flusher Showing Side Nozzles
- 6-I Improvised Street Flusher
- 6-J Improvised Street Flusher Showing 60° Angle Between Nozzle Bar and Line of Travel
- 7-A Mechanical Sweeper
- 7-B Vacuum Sweeper Tennant Model 100
- 7-C Vacuum Sweeper Tennant Model 88
- 7-D Dust Caused by Land Decontamination Equipment
- 7-E Motor Scraper
- 7-F Procedure for Using Motor Scrapers
- 7-G Motor Grader
- 7-H Motor Grader Plus Motor Scraper
- 7-I Front End Loader
- 7-J Procedure for Using the Motor Grader
- 7-K Bulldozing
- 7-L Earth Dikes Shield Edges of Decontaminated Areas from Fallout Radiation
- 7-M Plowing
- 7-N Result of Plowing
- 7-O Blade Snow Plow
- 7-P Procedure for Using the Snow Plow - Cold Weather

CHAPTER 1

OPERATIONAL PRINCIPLES OF RADIOLOGICAL DECONTAMINATION.

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1.1 Nature of Radiological Contamination

Areas and structures, made dangerous or uninhabitable by radioactive material, may be restored to usefulness by radiological decontamination. Since radioactivity cannot be neutralized, decontamination must be accomplished by removal of the material or by shielding the area or structure from the radiation. Radiation, like X-rays, cannot be seen, felt, heard, or smelled, and can be detected only by special instruments. It passes, with almost no decrease in strength, through such materials as thin wooden or sheet metal walls and roofs. Radiation is weakened, however, by thick sections of metal, concrete, earth, or water, and its strength decreases also with distance.

The major source of radiation, following a nuclear explosion, is fallout - radioactive dust and small particles which fall from the radioactive cloud caused by the burst. Fallout may appear hundreds of miles downwind and many hours after the explosion, where no damage from blast or heat has occurred. The fallout material, however, may be "hot" enough with radioactivity for many months to endanger unprotected human life and to require that areas be decontaminated to be inhabitable.

1.2 Scope of the Manual

This book, Volume II - Decontamination Operations, is the second volume of the two volume set, entitled "Prototype Civil Defense Manual for Radiological Decontamination." Volume I of the set is called Decontamination Planning and is concerned with the problems and responsibilities of Municipal and Zone Civil Defense Planners. Both books of the Manual are written primarily for use in localities where damage from the bomb explosion has not occurred and where recovery from fallout is the major problem facing the Civil Defense organization.

Volume II deals with the practical operational, "working level" problems which will be encountered in removing fallout radioactivity and restoring buildings and surface areas to safe, usable condition. It does not explain the selection of areas to be decontaminated nor the mathematics for determining safe exposure times for the decontamination workers. These matters are primarily the concern of Municipal and Zone Planners and are dealt with in detail in Volume I.

Volume II is intended for use by Zone Decontamination leaders and Decontamination Team captains. It describes the make-up of Decontamination Teams, the use of suitable, usually available, motorized and hand operated equipment, and suggests the modification of other equip-

ment. It is concerned with the operational problems which will be encountered both before and after a nuclear attack, in the fallout area, but outside of the damage area. The assumption is made that the usual municipal services of power, water, and communication are available, though their operating equipment may be in contaminated locations. Further, it is assumed that adequate supplies of vehicle fuel have been made available by the Civil Defense organization.

1.3 Experimental Background

A number of experiments have been performed by the Department of Defense, using low intensity radioactive simulants on typical buildings and terrain. Various decontamination procedures have been tried, and careful measurements have been made to evaluate the relative effectiveness of each. The information presented in the two volumes of this Manual is based on data accumulated during the Camp Stoneman, Camp Parks, and Camp McCoy decontamination experiments.

Where a particular manufacturer's equipment is named or described in the Manual, it is done so because the equipment was used during the Defense Department tests. Inclusion here is not intended to imply endorsement of either the manufacturer or his equipment. Equipment of similar characteristics, or equipment modified to perform similar functions, may be used to equal advantage.

1.4 Fallout Distribution on Surfaces

Fallout particles are carried downwind in the radioactive cloud and return to earth in much the same manner as snow, collecting primarily on horizontal surfaces. In the case of structures, the largest portion of horizontal surfaces are the roofs. Decontamination operations should be concentrated on roof surfaces, therefore, omitting the secondary horizontal surfaces, such as window sills, window muntins, etc., during the initial clean-up period.

On the ground, as well as on roofs, the light weight of fallout particles permits them to be blown about by the wind and to pile up in drifts against obstructions. Special attention should be paid to curbs, ditches, hedges, etc., and to roof structures like penthouses, chimneys, and gutters, which will cause drifting of fallout.

1.5 Basic Types of Surfaces to be Decontaminated

Because the required techniques are generally different, surfaces to be decontaminated are separated into three categories in this Manual. These categories are structures, paved areas, and natural areas. Each includes, of course, a wide variety of conditions, and all are subject to greatly increased complexity by cold weather and its incident ice

and snow. Chapters 2, 3 and 4 deal individually with these three categories, while Chapter 5 discusses the special problems associated with cold weather.

1.6 Principles of Decontamination

Decontamination is accomplished in accordance with one or more of three basic principles: cleaning the surface, removing the surface, and covering the surface.

Cleaning pertains to structures and to hard frozen, or paved areas. Methods of cleaning include washing, flushing, and sweeping.

Removing the surface is pertinent to soft, natural terrain, either with or without heavy vegetation, and it may be applied to structures and some types of pavings. Surface removal includes methods for picking-up methods for pushing-away the surface.

The principle of covering the contaminated surface will usually pertain to natural terrain in Buffer Zones - those strips which surround and protect decontaminated areas. Covering methods include turning-under soft earth, covering contaminated areas with clean fill, and constructing shielding dikes between cleared sites and radioactive areas.

1.7 Decontamination Teams

Teams consist of Team captains and workers, trained to perform specialized decontamination operations and supplied with specialized equipment for performing them. Team members, particularly for operations involving earth moving and street cleaning machines, should be recruited, where possible, among people already skilled in the use of these machines.

Chapter 6 and 7 consist of sections devoted to the make-up, equipping, and functioning of the various specialized Decontamination Teams.

1.8 Methods of Decontamination

Decontamination methods include firehosing, street sweeping, earth scraping, sod removal, etc. Standard and improvised Sanitation Department, Fire Department, and earth-moving construction equipment is used. For the purpose of description in this Manual, decontamination methods are separated into two classes, wet methods and dry methods, in Chapters 6 and 7 respectively.

1.8.1 Wet Methods - The wet methods consist of those which wash and flush away the fallout particles. In general, decontamination is begun at the high point and progresses downhill. Adequate drainage, away from the area of interest, is a requirement. Some surfaces, such as steep-sloped roofs, cannot be decontaminated except by wet methods.

1.8.2 Dry Methods - Dry methods include those which mechanically pick up and those which push the fallout particles to move them a safe distance away, as well as those which place shielding material in front of or over the particles. Grade (slope) is not important until it becomes too steep for a particular type of equipment. Dry methods are not recommended for roof surfaces unless water is unavailable and the roof slope is low.

1.9 Condition of Equipment

A Fire Department cannot function effectively without reliable mechanical equipment. Likewise, mechanical equipment is of utmost importance to effective, rapid decontamination. The machines used for this purpose, therefore, as for fire fighting, must be kept in satisfactory operating condition, and abuse in service must be avoided.

1.9.1 Operation of Equipment - It is assumed that the Decontamination Team members assigned to work with mechanical equipment are thoroughly familiar with its use. If skilled operators are not available, their replacements should be instructed as thoroughly as possible in proper operation and in the ways to avoid damaging the machines.

1.9.2 Maintenance of Equipment - Since dependable machine operation is vital to radiological decontamination, the machines available to the Zone should be put in good order and fully equipped, as part of pre-attack planning, and they should be maintained in good condition throughout the post-attack decontamination program. Oil, grease, cooling water, antifreeze in season, tires, etc. should be checked after each day's service. Maintenance and repair functions should be performed at night, to avoid tying-up the equipment during its working period.

1.9.3 Supply Requirements - Of equal importance to the condition of equipment, of course, is the supply of gasoline and diesel fuel for vehicle engines, and water for street flusher and firehose operation. Fuel and water tanks should be filled before each working period and efforts should be made to assure adequate supplies for all anticipated requirements.

1.10 Protection and Decontamination of Team Members

Drivers of vehicles, such as loaders, dump trucks, vacuum sweepers, etc., which carry contaminated material to the disposal sites, operate in close proximity to high concentrations of radioactivity. It is important, therefore, that they be protected, to permit them reasonably long allowable working times. Effective personnel shielding can be provided by sand bags, filled with uncontaminated sand or earth, stacked between the operator's seat and hopper.

On windy days, and especially during periods of drought, when the air is full of flying dust, dry method Decontamination Team members should wear scarfs or face masks.

Dry vegetation, refuse, and other combustible matter containing fallout particles should be disposed of by the methods described in this Manual. They should never be burned. Burning will not destroy radioactivity, but smoke will spread it, perhaps into the shelter or into areas already decontaminated.

Decontamination workers should be provided with a clean-up room or area where clothing can be changed and the workers can scrub, preferably in a shower. A radiation check should be made on each man before he enters the main shelter. Shoes particularly, should be cleaned carefully and checked for radioactivity.

1.11 Decontamination of Equipment

Vehicles and other equipment used for radiological decontamination may require cleaning after use, before maintenance and repair operations are performed. For most machines, sweeping or hosing, will be the most satisfactory techniques. The cleaning operation should be performed away from active manned areas, or care should be taken to wash all of the dirt removed into drains which will carry it away.

1.12 Modifications to Available Equipment for Decontamination

Conventional machines, as described in this Manual, may not be available in all Zones in sufficient numbers, when needed after a nuclear attack. It may be necessary to convert or modify other types of vehicles and machines for decontamination service. An example is given in Chapter 6, which includes a section on the construction and use of an improvised street flusher, made from a tank truck or vehicle drawn tank trailer, a water pump, and a fabricated pipe spray assembly.

Numerous other improvisations may be made, such as snow plow blades mounted on trucks or automobiles, used as scrapers. Sand bag ballast

and skid chains or deflated tires will help obtain traction. Vehicles such as farm tractors, jeeps, and pick-ups can be pressed into service. Fuel oil, milk, and chemical delivery trucks can be filled with water for street flushing, and tank trucks can be improvised by lining dump trucks or other bulk carrying vehicles with water proof tarpaulins or plastic films.

1.13 Improvised Decontamination Methods and Equipment

The wet and dry methods and the three categories of surfaces, discussed in the following chapters, describe the use of conventional commercial equipment. As pointed out in the preceding section, machines and vehicles, designed for other types of service, can be adapted to paved and natural area cleaning. Likewise, many improvisations are possible even when conventional commercial equipment is unavailable. Steps can be taken to assist the effectiveness of a decontamination program using common household implements and tools.

The protection provided by a shelter may be improved significantly, and thus the allowable exposure of decontamination workers outside the shelter may be extended, by operations such as washing down the roof over the shelter building and turning under the soil in the adjacent yard.

Improvisations and hand operations for decontaminating limited areas include such items as garden hoses, bucket brigades, house brooms, garden spades, wheelbarrows, hand propelled snow plows, and rotary tillers.

2.1 Scope

Decontamination of structures pertains to all buildings, regardless of size or occupancy, such as residences, shopping centers, industrial buildings, schools, churches, etc., single or multi-storied. Since fallout particles accumulate primarily on horizontal and near-horizontal surfaces exposed to the sky, this chapter deals with building roofs and the decontamination methods applicable to them.

Where buildings are intended for use or occupancy, decontamination will usually require cleaning of the entire roof area. Where buildings are located in the area being cleared as a Buffer Zone, it will frequently be sufficient to concentrate most effort on the roof areas nearest the Access Route or decontaminated Island. Particularly on concrete and masonry buildings in the Buffer Zone, whose structures provide shielding, back sloping roofs may sometimes be ignored altogether.

2.2 Roof Area

Building size has a direct bearing on decontamination operations. A number of small, individual buildings, while requiring no more actual decontamination time than one large building of the same area, will require more crew set-up and movement time.

Large buildings, on the other hand, may require excessive hose runs. At present there are many industrial and commercial buildings with roof surface areas in excess of six acres which may require hose runs of 300 feet or more to cover the entire roof. (See Figure 2-A). Provisions must be made, therefore, for extra lengths of hose, adequate water pressure, and sufficient manpower to move the hose.

2.3 Building Height

Decontaminating the roofs of multi-storied buildings involves special consideration not required for single-storied structures. Sufficient hose and water pressure to reach the roof, and manpower to lift the hose must be provided. Lobbing, one of the most effective methods, especially on steep slopes, may not be possible due to the height.

Where roof hydrants are available, the feeder hose from ground to roof is eliminated, and the work involved in decontaminating the roof surface is greatly reduced.

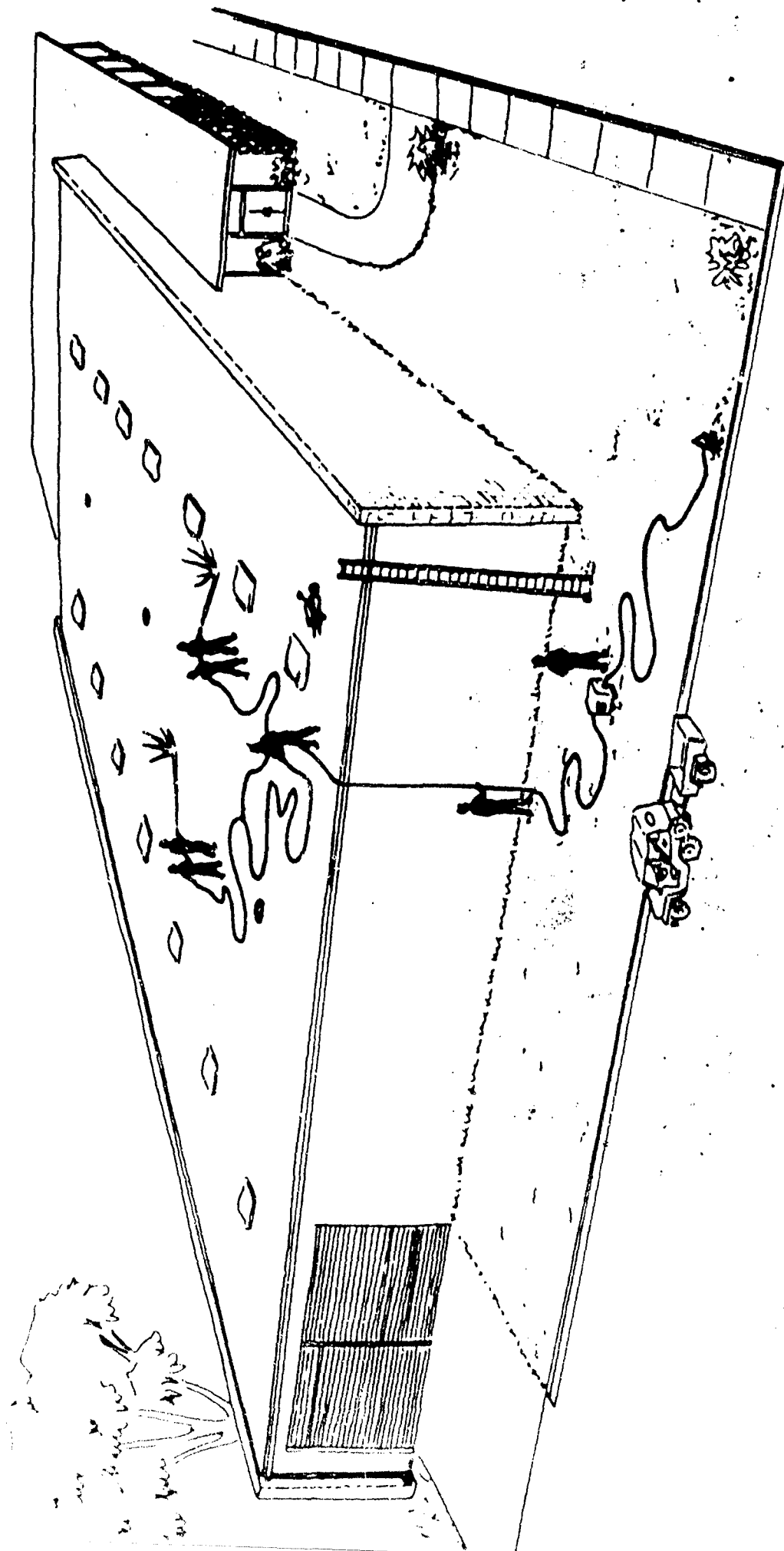


FIGURE 2-A

LARGE ROOF AREAS REQUIRE EXTENDED HOSE RUNS

On all multi-storied buildings extra safety precautions must be observed to avoid serious injuries or deaths from falls.

2.4 Climatic Conditions - Protection of Team Members

Freezing temperatures, which occur commonly in northern states during the winter, add greatly to the problems of roof decontamination, as do the presence of ice, snow, and strong winds. Decontamination Team members should avoid walking or standing on icy, sloped roofs and should use extreme caution on flat roofs. When necessary, ladders and life lines can be employed to decrease the hazard, and salt or sand can be spread to decrease slipperiness.

The subject of wintertime decontamination is reviewed at length in Chapter 5.

2.5 Roof Features

The roof construction features which most strongly affect decontamination are discussed in the following sections. They are: slope, surface texture, obstructions, and special configurations. Slope is the most important characteristic, since it governs both the readiness with which cleaning water and fallout material will run off, and the ease and safety with which the Decontamination Team can operate. Surface texture is important to the degree by which it passes or traps fallout particles in cracks, seams, and crevices. Obstructions include parapets, chimneys, gutters, penthouses, etc. which interfere with decontamination operations. They are discussed, along with other features of the roofs on which they commonly occur, in the sections following. Special configurations are those involving combinations and repetitions of roof slopes which affect decontamination.

2.6 Classification of Roof Slopes

For the purposes of this Manual, roof surfaces are classified by slope - flat surfaces, ranging from level to 1-on-12 slope; low slopes, 2-on-12 to 3-on-12; and steep slopes, 4-on-12 or greater. (See Figure 2-B). The distinction between low and steep slopes is made to differentiate between comparatively safe and comparatively hazardous conditions for standing and working.

2.7 Flat Surfaces

Flat roofs vary in slope from level to pitches of 1-on-12. Drainage is effected by perimeter gutters, downspouts, or interior drains, or by combinations of the three. The perimeter of the roof may be enclosed by a parapet wall, rising two or more feet above the roof surface, or by a cant two to six inches high. In some cases, no perimeter stop is provided (Figure 2-C).

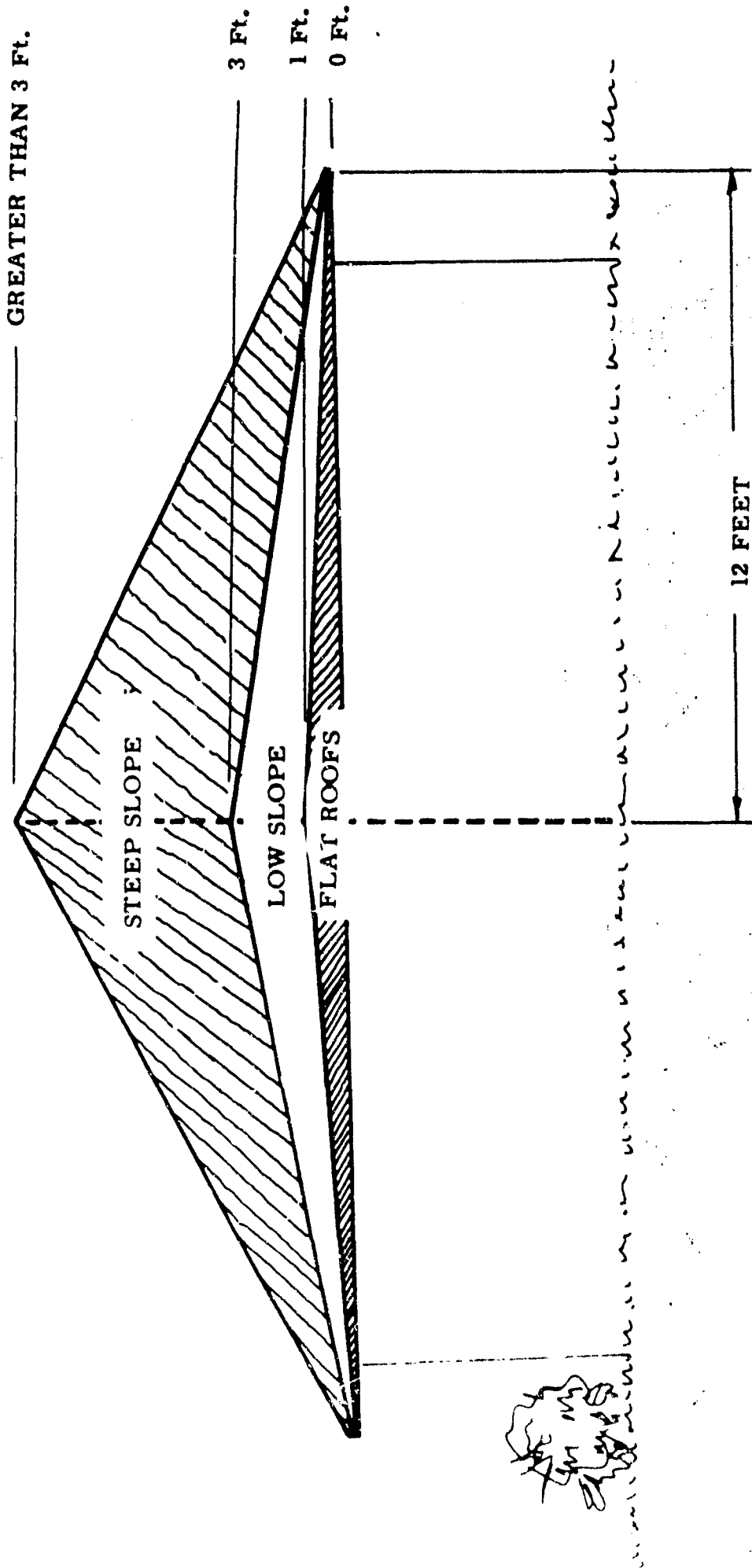


FIGURE 2-B ROOF SLOPES

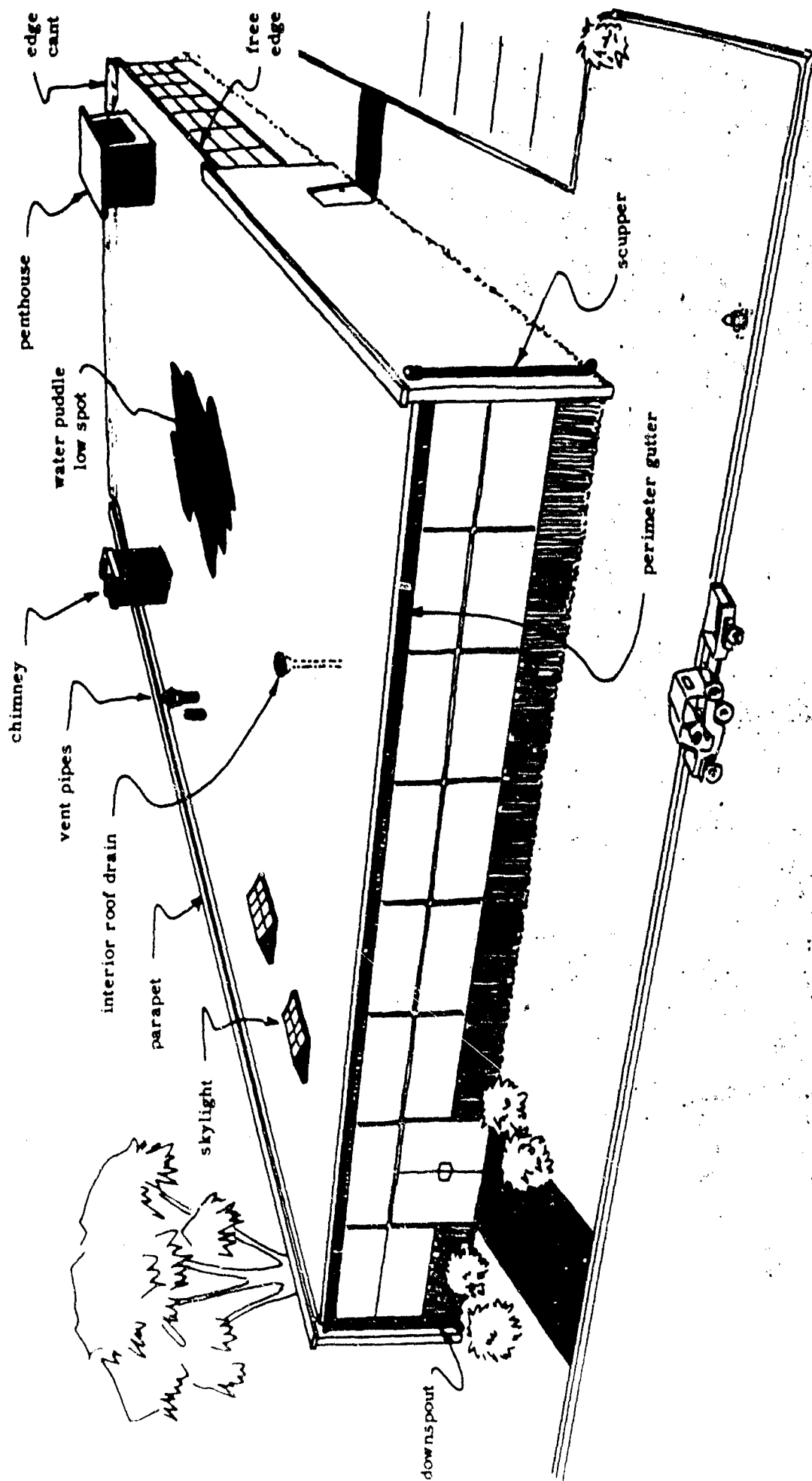


FIGURE 2-C

ROOF OBSTRUCTIONS PREVENT DRAINAGE FLOW

Normally, roof parapets are pierced by drainholes (scuppers) or the roofs are provided with interior drains. These tend to cause slowdowns in decontamination procedures. Low-canted roofs, or those without perimeter stops, allow hosing pressure to drive the fluid over any point along the edge. Roofs, especially on large buildings, often have skylights, fan openings, equipment penthouses, and similar obstructions which cause drifting of fallout particles and hinder decontamination operations. Very flat roofs frequently have low spots where water tends to accumulate and where no drains exist.

All such roof obstruction, combined with lack of drainage flow, serve as collection points for radioactive particles carried by water back-draining behind the decontamination team, thus decreasing the effectiveness of the decontamination procedure (Figure 2-C).

- 2.7.1 Decontamination of Flat Surface - Decontamination of fallout-covered roof surfaces consists of loosening and removing the contaminant. In the firehosing of heavy fallout, the highest practicable nozzle pressure has been found most advantageous. Run-off drains such as gutters and downspouts, must be kept free of clogging so that flushing may carry the loosened particles away from the roof to the sewer or drainage ditch. If gutters cannot be kept clear they should be removed.

In instances where the particle build-up is very heavy, run-off water from hosing may prove insufficient to transport the dirt particles much beyond the stream-impact area. In such cases, shoveling, or combined sweeping and shoveling, should be used, in addition to hosing.

- 2.7.1.1 Tar and Gravel Roofs - Composed of three to five layers of rag felt or jute saturated with coal-tar pitch or asphalt, each roof layer is set in a mopping of hot tar or asphalt. The top is finished with a covering of crushed slag, clean gravel, or marble chips.

Firehosing, the most applicable decontamination method for this type of roof, should begin at the center or high point of the building and proceed toward the edges or drains. Due to pressure exerted by the water stream, loose gravel tends to build up ahead of the firehosing team. This should be removed with hand shovels.

Specific attention should be given to drains and drain holes to prevent clogging from loose gravel.

- 2.7.1.2 Promenade Tile Surface - Consisting of three to five layers of rag felt or jute saturated with coal-tar pitch or asphalt, each surface layer is set in a mopping of hot tar or asphalt. The top is finished with a layer of flat quarry tile set in cement mortar.

Firehosing is the most applicable decontamination method and should begin at the center or high point of the building and proceed toward the edges and drains.

- 2.7.1.3 Roll Roofing - Composed of one or two layers of rag felt saturated with asphalt, each roof-roll layer is set in a mopping of hot asphalt. The top is finished with one or two layers of mineral surfaced roll-roofing laid in a mopping of hot asphalt.

Firehosing, the most applicable method of decontamination, should begin at the center or high point of the building and proceed toward the edges or drains. In the case of lapped roll-roofing, the hose stream must be directed with the lap to prevent lifting the surface and driving particles under the lap.

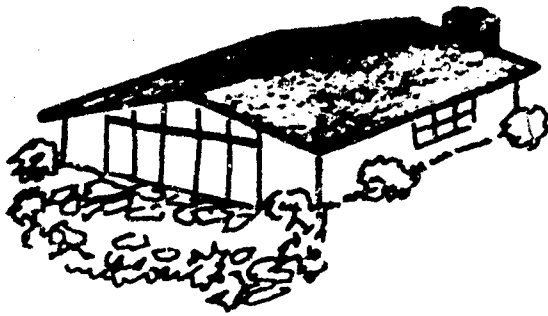
- 2.7.1.4 Exposed Concrete or Macadam - On structures where the roof surface is to be used for pedestrian traffic or vehicle parking, a topping of concrete or macadam may be poured over the conventional, built-up roof. In the case of covered walkways or canopies, the concrete slab is sometimes left exposed and is treated with a waterproofing compound such as silicone.

Firehosing is the most applicable method of decontamination and should begin at the building's center or high point, proceeding toward the edges and drains.

2.8 Low Slopes (Slopes 1-on-12 to 3-on-12)

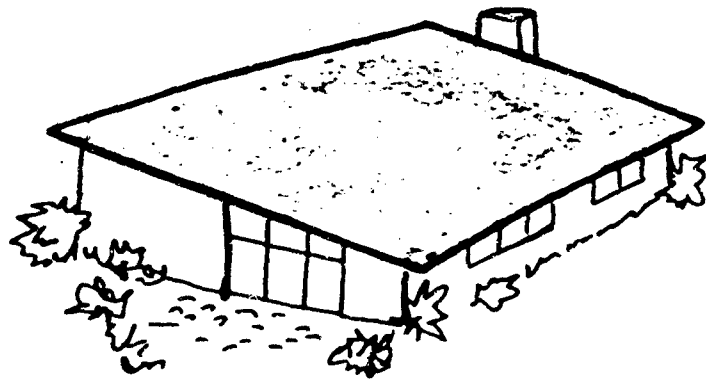
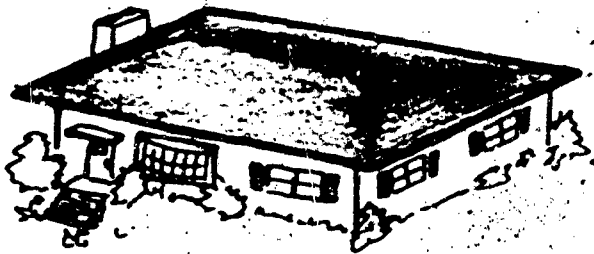
Generally, the term "low-slope roof" applies to common gabled and hipped roofs associated with small buildings and houses. However, for purposes of the Manual, "low-slope" includes flat arches, shells, and other types of construction where the roof angle is between 1-on-12 and 3-on-12 (Figure 2-D).

An advantage usually encountered with this type of slope, in addition to easier drainage, is the absence of restrictions such as parapets, scuppers, and interior drains. These roofs usually have edge gutters, or no gutters at all, allowing the decontamination team to wash the radioactive particles off the roof at any point along the edge. Edge gutters must be thoroughly cleaned and washed, or removed altogether, as they are natural pockets for collecting fallout particles.



◁ GABLE ROOF

▷ HIPPED ROOF



◁ SHED ROOF

FLAT ARCH ROOF

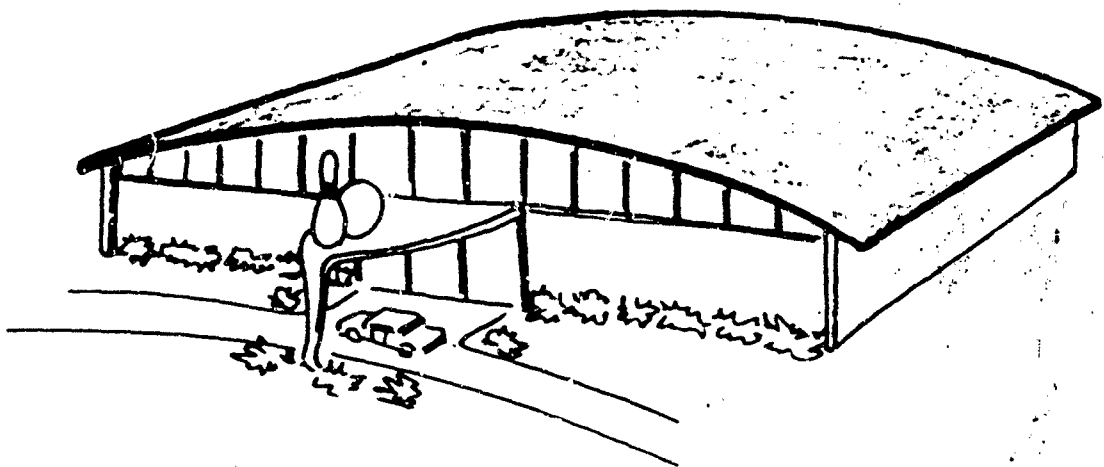


FIGURE 2-D TYPICAL LOW-SLOPE ROOFS

- 2.8.1 Asphalt Shingles - Made of rag felt or paper impregnated with asphalt, these shingles are mineral surfaced. The square butt and tab hex strip, varying in weight from 210 to 325 pounds per square, (100 sq.ft.) with shingles lapped to expose four or five inches to the weather, are the two most commonly used types.

Firehosing is the most applicable decontamination method, with operations starting at the roof-ridge line and proceeding toward the edges.

On the steeper roof pitches, lobbing may be used by the fire-hosing team, standing on the ground and directing the hose stream onto the roof. Lobbing begins at the roof ridge and works downward toward the edges and drains.

- 2.8.2 Wood Shingles - Composed of tapered wood, these shingles are lapped, exposing three to six inches to the weather.

Decontamination can be accomplished by either method outlined for asphalt shingles (2.8.1).

- 2.8.3 Slate Roof - Thin sheets of slate approximately 1/4 inch thick are lapped so as to expose 12 to 16 inches to the weather.

Decontamination can be accomplished by either method outlined for asphalt shingles (2.8.1). Care must be taken when the team is on the roof, as slate becomes slippery when wet. Furthermore, slate shingles are brittle and will break off, presenting an additional hazard to personnel.

- 2.8.4 Clay Tile Roof - Made of molded wet clay and burned in a kiln, clay tile is manufactured in two basic shapes, flat and curved. The flat tile roofs are similar in appearance to slate roofs. Curved tiles are laid with their deep corrugations running down the slope of the roof.

Decontamination of flat-surfaced tiles can be accomplished by either method outlined for asphalt shingles (2.8.1). Similar to slate roofing, these tiles are slippery when wet. They are also brittle, and create a hazard for anyone on the roof.

Curved surface tiles should be decontaminated only by lobbing a water stream onto the roof from the ground (2.8.1), as the corrugations make standing on the roof extremely hazardous.

- 2.8.5 Asbestos Shingles - Similar to wood shingles in size, shape, and somewhat in appearance, these shingles are composed of about 15 percent asbestos fiber and 85 percent cement, formed under high pressure.

Asbestos shingles can be decontaminated as outlined for asphalt shingles (2.8.1). Like slate and clay tile roofs, they are extremely brittle and become slippery when wet.

- 2.8.6 Sheet Metal and Corrugated Roofs - Sheet metal roofs are made of thin sheets of metal about 24 inches wide, varying in thickness from 28 to 18 gauge, with the edges joined by a variety of seams. The most commonly used seams are standing, flat, and batten, depending upon the slope of the roof. All seams run down the slope of the roof. Sheet metal roofs are generally applied over wood sheathing and are, therefore, capable of supporting the weight of the decontamination operation.

Corrugated roofs are composed of either metal, fiberglass, or transite, manufactured in widths of approximately 24 inches and corrugation depths of 1-1/2 to 2-1/2 inches. The corrugations run down the slope of the roof with end laps of about six inches and edge laps of two corrugations. This type of roofing is popular for industrial buildings because of its low initial cost. Corrugated roofs normally span two or more feet unsupported, between rafters and purlins. In many instances the corrugated roofing is designed to support little if any load. The decontamination team should be extremely careful if they work on the roof and should do so only after receiving assurance that the roof will support them safely.

Both sheet metal and corrugated roofs can be decontaminated by the methods outlined for asphalt shingles (2.8.1). Due to the slippery nature of wet metal roofs and the unsure footing on corrugated surfaces, care must be exercised by personnel on the roof itself. The lobbing method is recommended for use where possible.

- 2.8.7 Tar and Gravel Roofs - This type of surface is increasingly popular in modern-style, low-slope roofed buildings. The slope of such roofs makes them more conducive to cleaning than flat, horizontal surfaces. (See Section 2.7.1.1).
- 2.8.8 Roll-Roofing - The slope assists in removing particles from the surface by firehosing. Lobbing is practical for the steeper slopes, providing the gutters are thoroughly cleaned and washed, or removed.

A second type of build-up roofing, composed of successive layers of rag felt and asphalt, and topped with a layer of hot asphalt providing a smooth even surface, may also be encountered. This type of roof can be treated in a similar manner to conventional roll-roofing, and because of the smoothness of its surface, it is more easily decontaminated.

2.9 Steep-Slope Roofs

Steep-slope roofs are those where the slope is greater than 3-on-12. Consequently, this grouping includes not only the common gable, gambrel, and hipped roofs, but barrel and peaked arches, tepees, domes, and shells (Figure 2-E). The steep slopes offer easy drainage, and the normally unobstructed edges aid in decontamination operations.

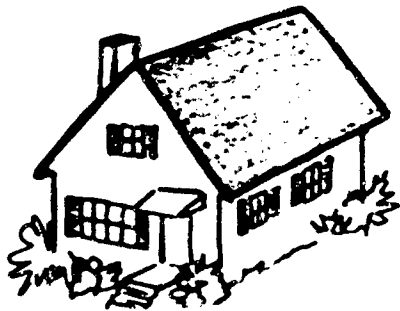
2.9.1 Materials Used in Steep-Slope Roofs - Steep-slope roofs generally use materials found in low-slope roofs. These are: asphalt, wood, and asbestos shingles; slate, tile, and roof-roofings; sheet metal and corrugated roofings.

2.9.2 Use of Lobbing to Decontaminate Steep Slopes - Decontamination of steep slopes should be limited to the lobbing technique, because standing on steep wet slopes is extremely dangerous.

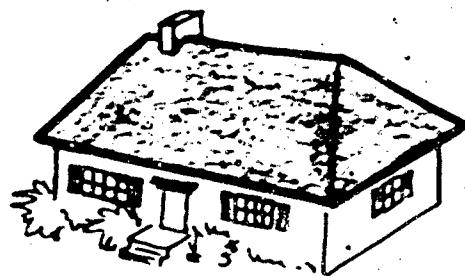
2.10 Special Configurations

In many instances, roofs are formed of multiple gables or arches (See Figure 2-F). While from the standpoint of slope, they are described in the preceding sections, the repetitions of form create interior valleys and reverse slopes which hamper the run-off of water. Typical examples of these multiple forms are multiple barrel arches, saw teeth, butterflies, umbrellas, and folded plates.

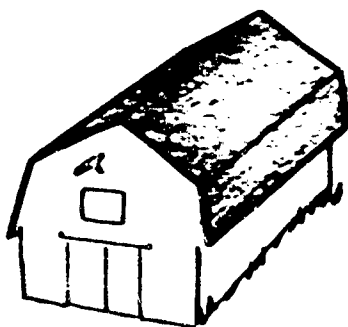
Decontamination should be accomplished by the team working on the roof beginning at the high point of the roof and proceeding toward the valleys. Once the particles have been flushed into the valleys, they must then be driven toward the drains. Sustained use of these drains may cause them to become clogged, especially where tar and gravel surfaces are encountered, and it will be necessary to clear them before continuing.



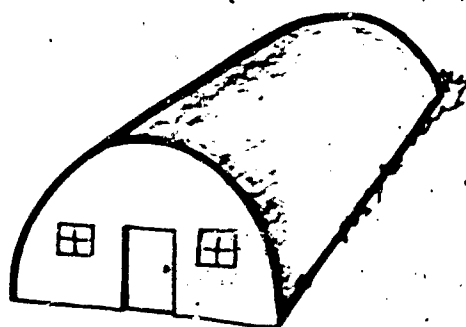
GABLE



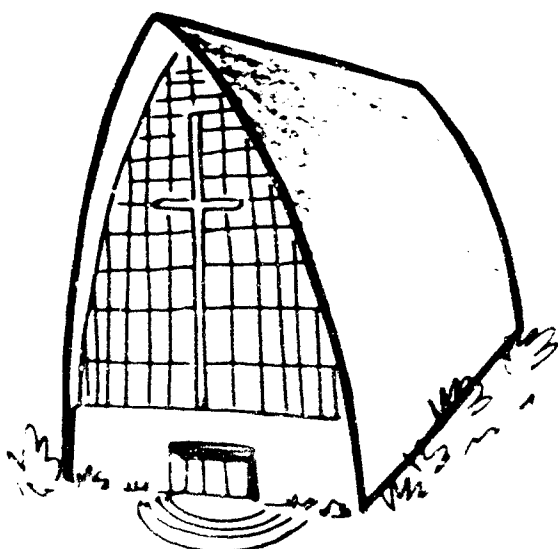
HIP



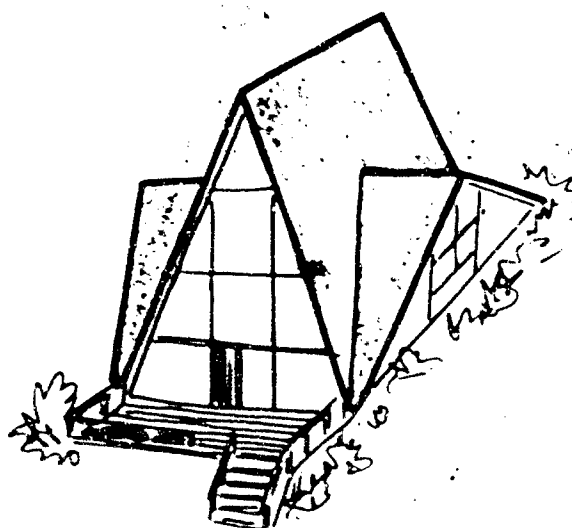
GAMBREL



BARREL ARCH

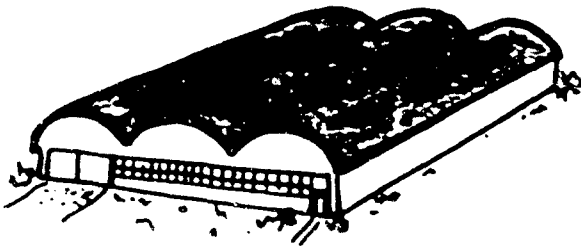


PEAKED ARCH

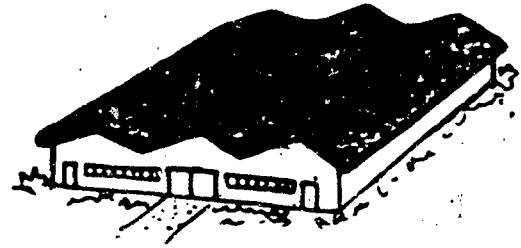


TEPEE

FIGURE 2-5 EXAMPLE OF STEEP-SLOPE ROOFS



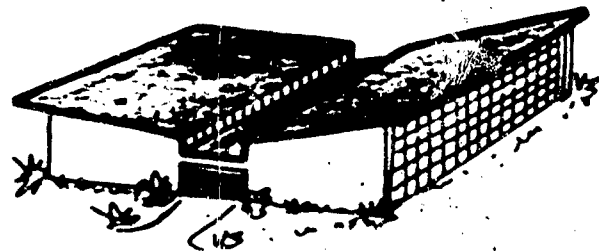
MULTIPLE BARREL ARCHES



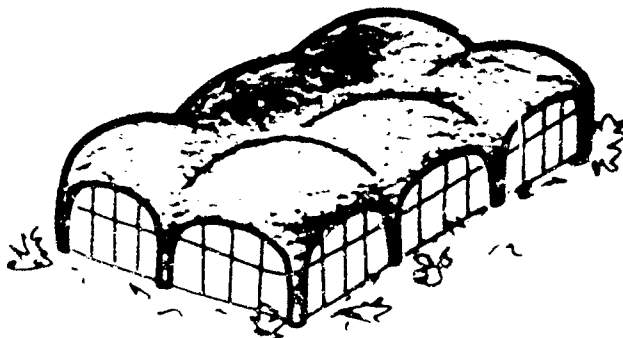
FOLDED PLATE



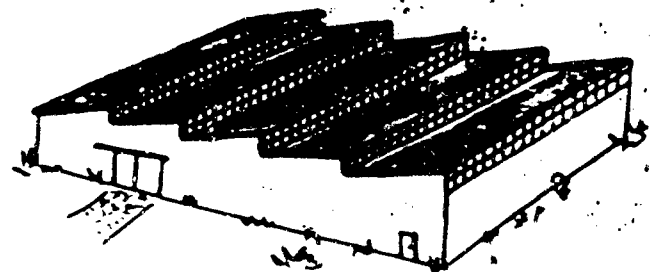
BUTTERFLY



BUTTERFLY WITH DROPPED PANEL



UMBRELLAS



SAW TOOTH

FIGURE 2-F

**SPECIAL ROOF CONFIGURATIONS
PRESENTING DECONTAMINATION PROBLEMS**

3.1 Scope

Paved areas are those areas which are surfaced with portland cement concrete, bituminous materials, and brick or stone blocks. They do not include untreated surfaces such as soil-cement, bituminous impregnated gravels, and sand-clays. The latter surfaces are discussed under Natural Areas, in Chapter 4.

Paved areas constitute major portions of the exposed terrain in urban communities, with the ratio of paved to natural area in the suburbs decreasing as the population density decreases. However, pavement still constitutes an important part of the area of even small residential towns. Paved areas include roads, driveways, parking areas, walkways, playgrounds, and airport runways and aprons.

The decontamination of paved surfaces is far more efficient than that of unpaved surfaces, from the standpoints of manpower and equipment. For this reason, Planners will probably select areas to be decontaminated which include as much pavement as possible, and Zone Decontamination leaders will find that a high proportion of the work of their teams is on pavement, even in low population-density regions.

The reasons for decontamination of large areas are covered thoroughly in Volume I of this Manual. In brief, "Islands", including shelters for the population, and "Access Routes", to service the Islands with food and supplies, are required. Each Island and Access Route must be bordered by a relatively wide "Buffer Zone" to protect the people in it from the surrounding radioactivity. Included in these areas will be space for parking and maintenance of Recovery Operation vehicles, including those of the Decontamination Teams.

3.2 General Characteristics of Paved Areas

The characteristics which control the effectiveness of decontamination operations on paved surfaces and dictate the choice of methods are discussed below. They include drainage, slope, crown, size, surface material and condition, and the presence and distribution of obstructions.

- 3.2.1 Drainage (Figure J-A) - Adequate drainage of the surface is important for wet methods of decontamination. Many paved areas have no special provisions for drainage, and reliance is placed upon runoff along the edges. In some instances, the water is collected in ditches or by catch basins and storm sewers. If the paved area is very large, as in a shopping center parking lot, interior troughs and catch basins or sewers are usually provided.

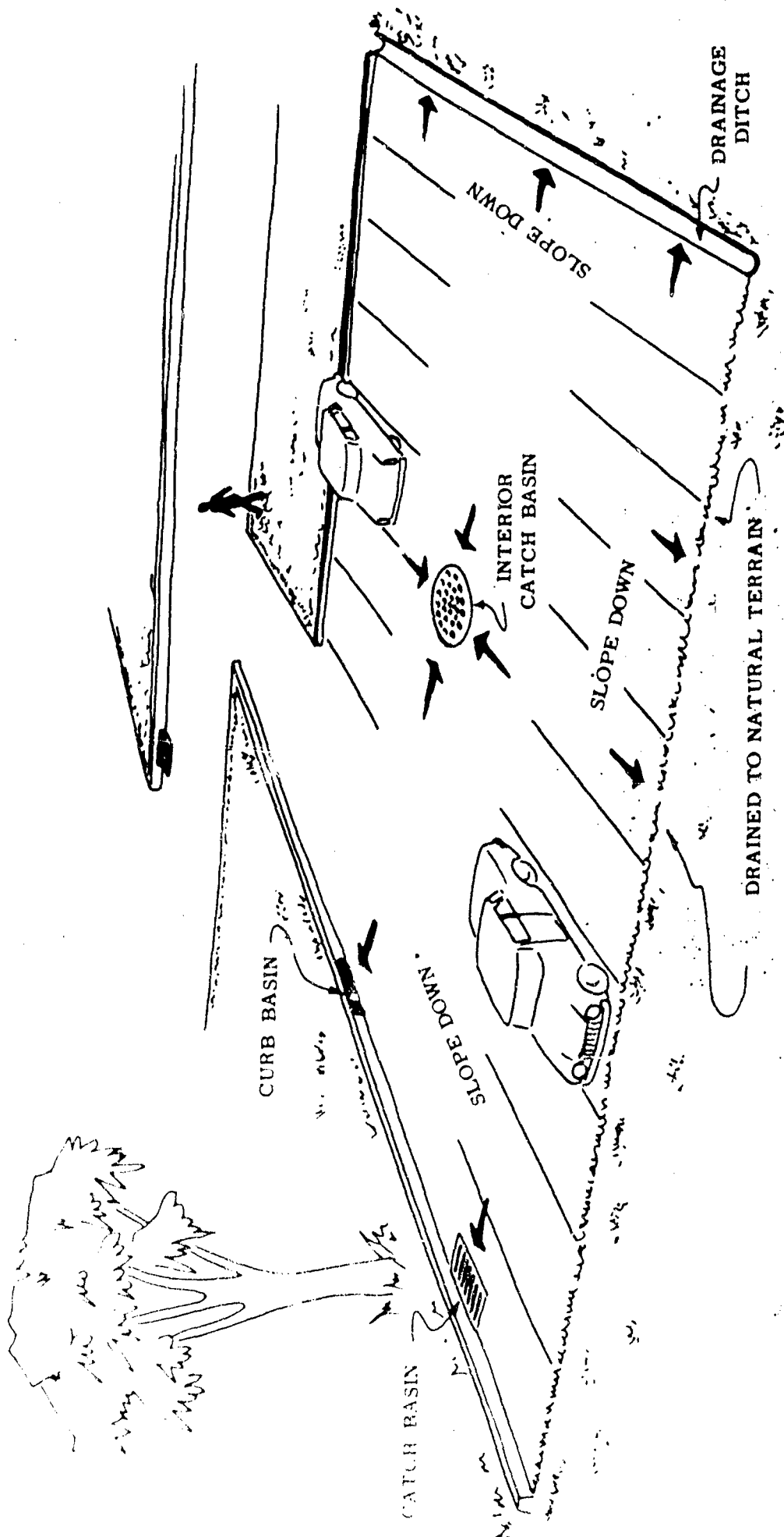


FIGURE 3-A TYPES OF DRAINAGE FOR PAVED AREAS

Wet decontamination methods should always be directed to push the fallout particles to the drainage system. Where run-off water is collected in ditches or on the unpaved terrain, the fallout particles should be removed to a safe location or covered over with a clean layer of shielding earth. The procedures for accomplishing this are explained under Decontamination of Natural Areas, in Chapter 4.

Where run-off is removed through drains and storm sewers, attention must be paid to keeping the drains and sewers clear, to prevent clogging and back-up of the highly concentrated fallout material.

- 3.2.2 Slope (Figure 3-B)- The slopes of paved areas generally follow the natural topography of the land. Roads and walkways have average slopes which vary from zero to 15 percent. They may undulate up and down repeatedly, however, along this average slope. These small, frequent changes in slope create crests and valleys which will affect drainage, and thus the sequence of decontamination operations.

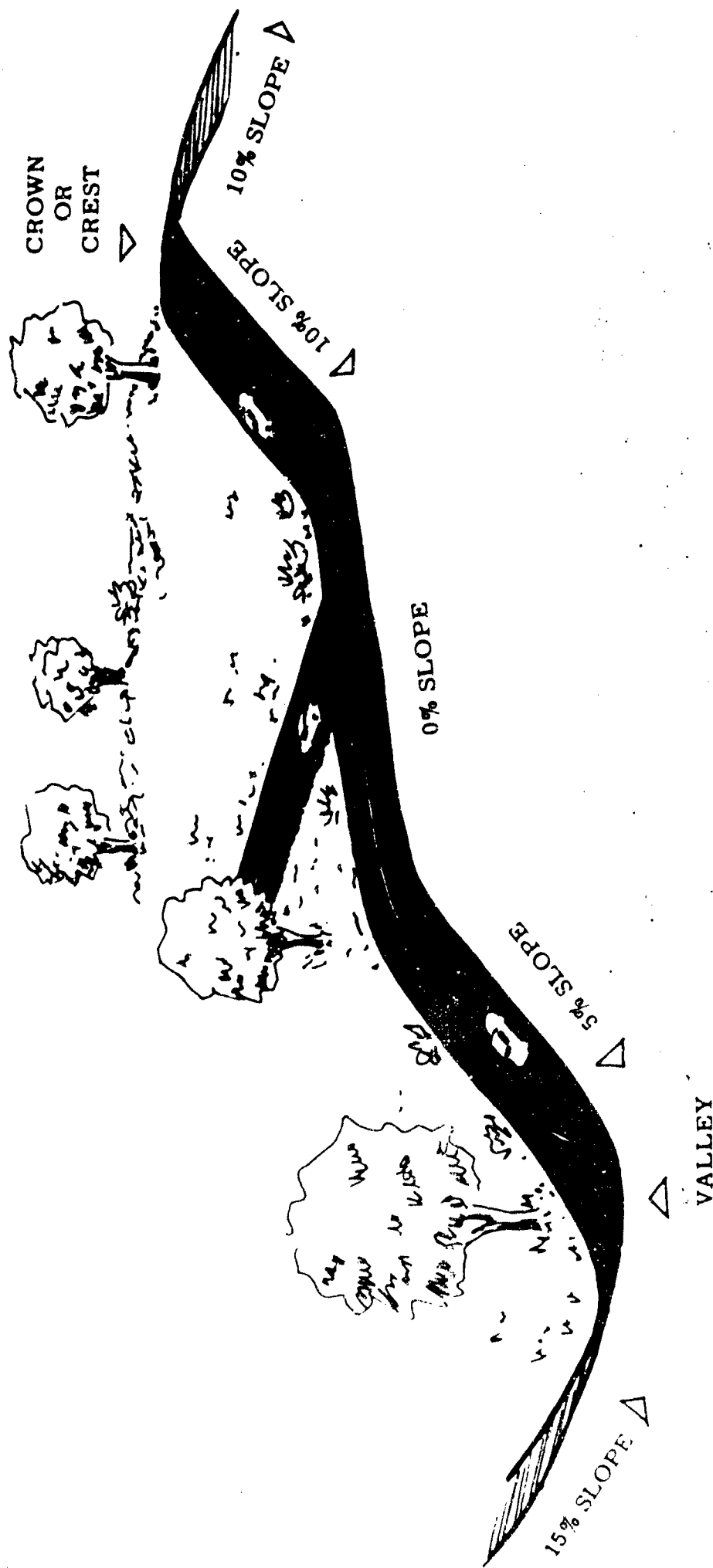
Parking areas usually have slopes of three percent or less. As with roads and walkways, the slopes may vary both in degree and direction within their boundaries.

- 3.2.2.1 Effect of Slope on Wet Decontamination - Slope can be beneficial to wet decontamination by assisting in the washing action and the run-off of the water. Consideration should be given to changes in the direction of slope and to the location of drains. All wet decontamination operations should begin at the high point of the slope and progress downward toward the drainage point.

A mechanical street flusher can be utilized by moving back and forth across the slope, progressing downward at each change in direction. If the slope forms a bowl-like depression with a drain at the bottom, the flusher may be able to move around the slope, spiralling in and down toward the drain.

Manual firehosing teams will use the same general technique. However, due to the difficulty of dragging the heavy, stiff hoses and the limitations caused by hose length, the teams will probably be restricted to working directly downhill, then stopping and moving to the top to start again.

- 3.2.2.2 Effect of Slope on Dry Decontamination - Slope has little or no effect upon the results obtained using dry decontamination methods. Work can progress in any direction with equal effectiveness, except when very steep slopes are encountered and the mechanized equipment cannot travel up the grade.



PAVED ROADS AND WALKWAYS
CHANGE IN BOTH SLOPE AND DIRECTION

FIGURE 3-B

- 3.2.3 Crown - Roads and runways are constructed with crowns to eliminate cross drainage and the formation of puddles and ice patches on them. Road and runway crowns vary between 1/8 inch and 3/8 inch per foot of width, except on banked curves where drainage is toward the inside edge. Sidewalks are usually pitched two percent down toward the road.

Crowning assists wet decontamination, especially where no natural slope exists, by directing the water flow toward the edge ditches or drains. Frequently, on large, flat, paved areas, which are not provided with drains, low spots or depressions occur (Figure 3-C). These are collection sites for backflow of water and fallout particles and usually will require more than one decontamination operation to clean.

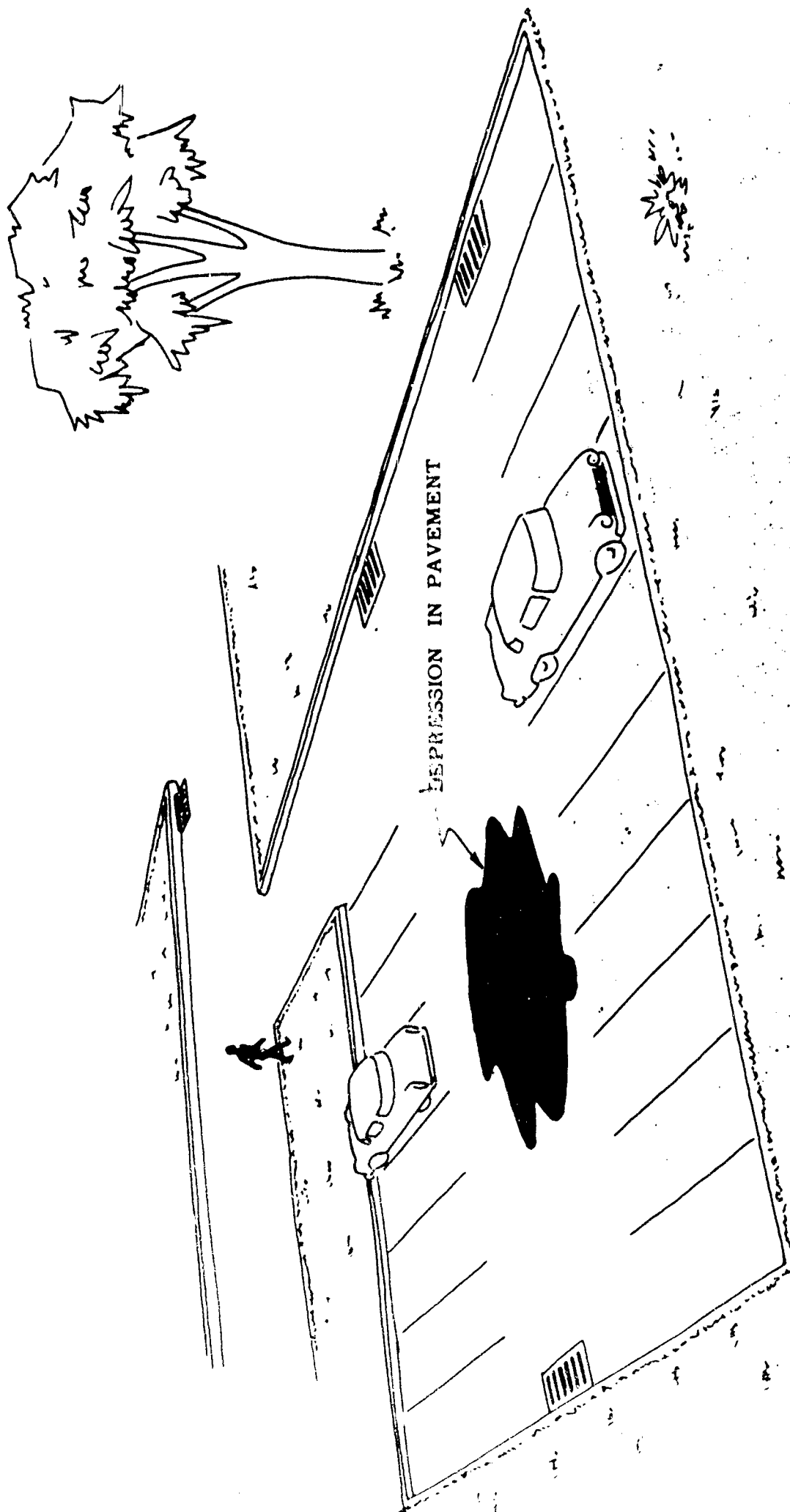
Dry decontamination methods are unaffected by surface depressions. They are especially recommended for use on poorly drained or uncrowned paved areas.

- 3.2.4 Size of Paved Area - Paved surfaces vary in size from three feet wide sidewalks to parking lots many acres in extent. Whenever the area is large enough, motorized cleaning equipment should be used.

As the length and width of paved areas increase, the distance that particles must be moved to drainage points also increase. The build-up of loose material ahead of the water streams of wet decontamination operations thus becomes greater as area size increases, to the point of hindering progress. Hand shoveling should be employed to remove excessive quantities of loose material. (See Figure 3-D)

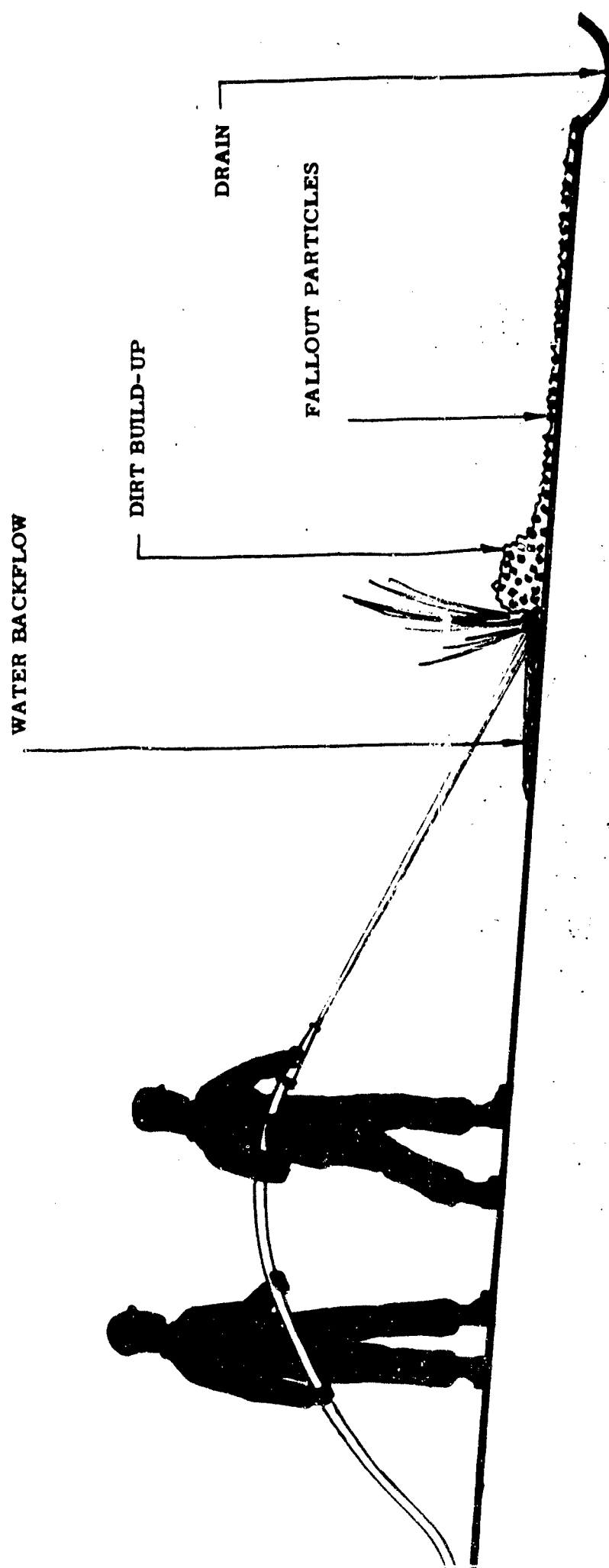
Although the distance that fallout particles can be moved by wet decontamination methods, without the assistance of hand shoveling, depends upon the total amount of debris present, a general rule of thumb can be stated. Where the fallout is to be moved less than 50 feet to the drains, wet methods can be used. For longer distances dry methods are recommended.

- 3.2.5 Surface Condition - The condition of the surface can alter the effectiveness of all decontamination methods. Cracks or pot-holes in the pavement become collection points for fallout particles. Motorized equipment for both wet and dry methods will tend to skip over these places, leaving "hot spots". These must later be located either visually, or by radiation detecting instruments and cleaned out by hand sweeping and shoveling. Fire-hosing teams can wash the crevices clean as they move along. However, their progress will be greatly retarded by an excessively broken surface.



LOW SPOTS OR DEPRESSIONS MAY COLLECT WATER
AND FALLOUT PARTICLES

FIGURE 3-C



THE GREATER THE DISTANCE TO THE DRAIN POINT
THE GREATER THE ACCUMULATION OF FALLOUT
AND DIRT

FIGURE 3-D

PARTICLE BUILD-UP IN WET DECONTAMINATION

- 3.2.6 Obstructions - Few paved areas, unless very small, are completely free of obstructions which will hinder decontamination. Large parking lots have power or telephone poles, curbs, parking bumpers, and fire hydrants; roads have safety isles and lane dividers; airports have direction signs and lights; and playgrounds have playground equipment. All paved areas are subject, from time to time, to construction and repair operation. Sections of paving are torn up, holes are dug, and dirt is piled up. Roads may be completely blocked. It is advisable for both the Zone Planner and Decontamination leader to maintain a continuing, up-to-date record of construction projects in their territory, before a nuclear attack.

All of the above "permanently" attached objects will tend to cause drifting of fallout particles and will obstruct the passage of motorized equipment. Hand clean-up operations will be necessary around all such obstructions.

In addition to fixed obstructions, many movable items will be found in paved areas. These should be removed to beyond the area being cleaned before the regular motorized operation is begun. Such temporary obstructions include parked vehicles, benches, signs, not fastened playground equipment, saw-horses and warning lanterns at construction sites, waste cans, and general refuse and debris.

- 3.2.7 Areas Bordering Pavement - When it is necessary to decontaminate unpaved areas adjacent to paved areas, as Buffer Zones or for other purposes, the methods applicable to natural terrain should be used. These are treated at length in Chapter 4.

These areas include gravel shoulders, unpaved median strips, tree lawns, flower beds in shopping malls, etc. In general, their decontamination will require a great deal more time and labor than will the paved area itself. Objects removed from the pavement preparatory to cleaning it should not be set down in other areas which must also be decontaminated.

3.3 Equipment

Large paved areas are well suited to motorized decontamination, utilizing conventional equipment developed for street and parking lot cleaning. Highly efficient machines are available for both wet and dry cleaning methods and for wintertime snow removal. Such equipment is often stored and maintained in garages of the Municipal Sanitation Department, the Department of Streets, or the Department of Parks and Playgrounds. It may be found in the garages of contractors who have shopping center, sports stadium, or street maintenance contracts. Particularly for wet decontamination and snow removal methods, motorized equipment can often be improvised, if conventional machines are unavailable.

Wet method machines for paved areas consist of conventional and improvised street flushers. Dry method equipment includes mechanical and vacuum sweepers. Snow removal machines are snowplows, scrapers, graders, and loaders with trucks.

Where no type of motorized equipment can be obtained, and for small and irregular areas, manual firehosing preferably, or hand sweeping, or vacuum cleaning, should be used. The efficiencies of these methods, however, are far below those of any of the motorized methods.

Full discussions of wet and dry decontamination methods and equipment for paved areas are contained in Chapters 6 and 7, respectively. The latter chapter also discusses methods and equipment for the removal of snow.

3.4 Classification of Paved Areas

Paved areas are classified by their surface material. The three most prevalent surfaces are portland cement concrete, bituminous materials, and brick or stone block paving.

- 3.4.1 Portland Cement Concrete - This material is used extensively for all types of air strips, and land vehicle and pedestrian traffic. The surface is usually smooth and easy to clean, when it is in good condition. Construction and expansion joints, which are located from 15 feet to 40 feet apart, require special care, however.

Weathering and aging of concrete often result in surface crazing and cracking. Both of these conditions cause a decrease in the efficiency of decontamination operations. A very common method for repairing concrete surfaces is by patching with bituminous materials. Patches also cause discontinuities in the surface, which require special care and result in lower efficiency.

Any of the wet or dry decontamination methods are applicable, with strong preference being given to the mechanized methods because of their much greater speeds.

- 3.4.2 Bituminous Materials - Like portland cement, bituminous materials are used extensively for paved surfaces. The two most common finishes are an open-faced surface, possessing a roughened texture to decrease vehicle skidding, and a sheet asphalt finish which has a dense, smooth surface. Sheet asphalt is used mainly for city pavements because the surface is easily cleaned, while the open-faced surface is used on highways and on steep grades because of the better traction its roughness provides.

Newly finished bituminous surfaces are free from joints and can be decontaminated readily by any of the wet or dry methods. When the surfaces age, however, potholes frequently develop and are repaired by bituminous patches which seldom blend completely into the surfaces. Both unrepaired potholes and repair patches constitute obstacles, which will cause "hot spots" to be left after high speed, mechanized decontamination.

- 3.4.3 Brick and Stone Block Pavements - Both of these materials are still found in many communities, principally on steeply graded roads. New surfaces, however, are seldom made with them. Pavement block surfaces are characterized by the exposed faces of the blocks surrounded by joints filled with hot asphalt cement or portland cement grout. Because of the numerous joints, cleaning these pavements is very time consuming. The joints, being depressed below the faces of the blocks, tend to accumulate particles.

The most efficient methods of decontamination are firehosing and street flushing, since the stream pressure will wash the particles out of the joints and flush them away.

3.5 Selection of Method of Decontamination

After the Zone Decontamination leader has determined the characteristics of the paved area, with respect to drainage, slope, crown, size, surface material, and condition, and has considered available equipment and manpower, he should select the decontamination method best suited for the task. Figure 3-E summarizes the surface materials discussed in this chapter and relates them to the several mechanized decontamination methods.

FIGURE 3-E

	Mechanical Sweeper	Vacuum Sweeper	Street Flusher	Firehose
Portland Cement Concrete	A	A	B	C
Bituminous Materials	A	A	B	C
Brick and Stone Block	A	A	B	C

A - Applicable to areas where there is enough space to maneuver.

B - Recommended for pavements less than 100 feet between drains due to accumulated build-up of particles from preceding passes.

C - Recommended for smaller areas or when motorized equipment is not available.

CHAPTER 4

DECONTAMINATION OF NATURAL AREAS

ABSTRACT

The decontamination of natural (unpaved) areas is much less efficient than that of paved areas. However, particularly for Buffer Zones, varying amounts of it will be required, depending in general upon the degree of urbanization of the Zone. Dry methods only are suitable for natural area decontamination, except for limited use of wet methods on hard-firm surfaces.

The basic concepts for decontaminating natural areas are: picking the surface up, pushing the surface away, turning the surface under, and covering the surface over. The methods suitable for these concepts are discussed.

Decontamination is greatly affected by combinations of the factors: slope, vegetation cover, earth composition, and moisture content. These factors and their effects are described. The suitability of the various methods for different conditions is summarized.

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4.1 Scope

Although paved surfaces permit decontamination methods which are far more rapid than are those for unpaved surfaces, the latter represents much of the area which will require decontamination following a nuclear attack. Open spaces and routes intended for occupation will be selected from paved areas and roads, as far as possible, by the Zone Decontamination Planner. However, much natural terrain will require decontamination for Buffer Zones, parking areas for Recovery Operation vehicles if no paved lots are suitably located, and possibly for children's recreation areas during long periods of recovery.

Natural terrain is defined as any land surface not paved with portland cement concrete, bituminous material, or brick or stone blocks. It includes loose or bituminous impregnated gravel roads and shoulders. Typical natural areas, most likely to be included in Buffer Zones, and, therefore, requiring decontamination, will include lawns, parks, tree lawns, median strips, unpaved shoulders, woods, and fields along roadsides. (See Figure 4-A)

- 4.1.1 Decontamination Methods for Natural Areas - Dry methods only are suitable for warm weather natural area decontamination. In cold weather, bare frozen surfaces can sometimes be cleaned effectively by firehosing or flushing.
- 4.1.2 Factors Affecting Decontamination - Almost any conceivable factor affecting the make-up and condition of the terrain will also affect the decontamination operations on it. The various combinations of slope, moisture content, vegetation, and earth composition are essentially unlimited, and may vary widely on the same plot of land. In general, "ideal" characteristics for decontamination of natural areas are:
 - 1. Soil surface free of rocks and large vegetation
 - 2. Soil firm, but not hard
 - 3. Soil moist, but not wet
 - 4. Soil cohesive and of uniform composition
 - 5. Soil surface smooth and flat.

4.2 Concepts of Decontamination of Natural Areas

While only dry methods are applicable, there are four basic concepts for the decontamination of natural areas. They are:

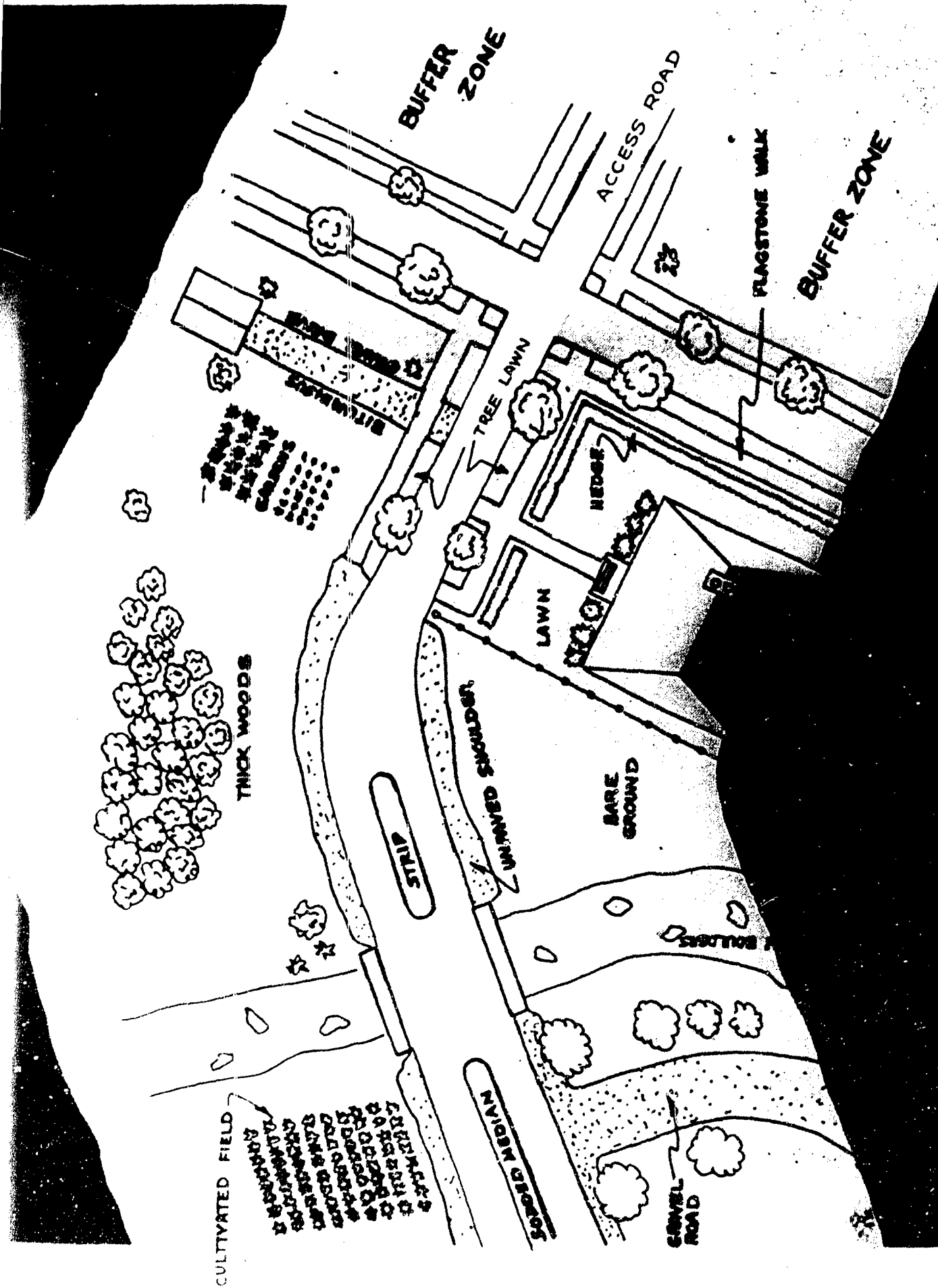


FIGURE 4-A PROBLEMS OF NATURAL AREA DECONTAMINATION

1. Picking the surface up
2. Pushing the surface away
3. Turning the surface under
4. Covering the surface over.

The first two concepts correspond to the basic principle of removing the surface, and with it, the fallout.

The second two concepts correspond to the principle of covering, or shielding, the surface. Since covering does not destroy the radioactivity, it will continue to remain a potential hazard. Anything which disturbs the surface, such as rain, wind, digging, or continuous traffic, may decrease the thickness of the shield, and recreate an active hazard. For this reason, and because effective shielding for anyone directly over the radioactive material will require about three feet of earth, covering and turning-under techniques should be reserved for Buffer Zone decontamination only.

- 4.2.1 Picking-Up the Surface - The objective, in this concept, is to remove the surface of the soil without removing more of it than is necessary. Tests have established that removal to a depth slightly greater than the depth of the surface irregularities will effectively remove the fallout particles. Usually, removal depths of two to four inches will be sufficient. Fissures and cracks which penetrate deeper than this may contain fallout which will remain as "hot spots", requiring manual removal.

Mechanized equipment for surface pick-up includes the motor scraper, which cuts and collects a controlled thickness of earth as it advances. The manual counterpart of machine scraping is hand shoveling into a wheelbarrow or truck. The hand shoveling method should be limited to small or inaccessible areas and to "hot" spot removal.

Experiments have demonstrated the feasibility of decontaminating grass covered lawn by rolling up and removing strips of sod. (See Figure 4-B). A hand propelled sod cutter was used in the experiment, though sod removal using simple manual garden tools can be accomplished. Neither method is as rapid or efficient as mechanically scraping-up the sod.

- 4.2.2 Pushing-Away the Surface (Figure 4-C) - As in the pick-up method, the objective is to remove the particles with a minimum removal of soil. Normally, removal of the top two to four inches of soil is sufficient, and the remaining "hot spots" caused by spillage or fissures can be manually removed.

3.2.6 Obstructions - Few paved areas, unless very small, are completely free of obstructions which will hinder decontamination. Large parking lots have power or telephone poles, curbs, parking bumpers, and fire hydrants; roads have safety isles and lane dividers; airports have direction signs and lights; and playgrounds have playground equipment. All paved areas are subject, from time to time, to construction and repair operation. Sections of paving are torn up, holes are dug, and dirt is piled up. Roads may be completely blocked. It is advisable for both the Zone Planner and Decontamination leader to maintain a continuing, up-to-date record of construction projects in their territory, before a nuclear attack.

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In addition to fixed obstructions, many movable items will be found in paved areas. These should be removed to beyond the area being cleaned before the regular motorized operation is begun. Such temporary obstructions include parked vehicles, benches, signs, not fastened playground equipment, saw-horses and warning lanterns at construction sites, waste cans, and general refuse and debris.

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These areas include gravel shoulders, unpaved median strips, tree lawns, flower beds in shopping malls, etc. In general, their decontamination will require a great deal more time and labor than will the paved area itself. Objects removed from the pavement preparatory to cleaning it should not be set down in other areas which must also be decontaminated.

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Paved areas are classified by their surface material. The three most prevalent surfaces are portland cement concrete, bituminous materials, and brick or stone block paving.

- 3.4.1 Portland Cement Concrete - This material is used extensively for all types of air strips, and land vehicle and pedestrian traffic. The surface is usually smooth and easy to clean, when it is in good condition. Construction and expansion joints, which are located from 15 feet to 40 feet apart, require special care, however.

Weathering and aging of concrete often result in surface crazing and cracking. Both of these conditions cause a decrease in the efficiency of decontamination operations. A very common method for repairing concrete surfaces is by patching with bituminous materials. Patches also cause discontinuities in the surface, which require special care and result in lower efficiency.

Any of the wet or dry decontamination methods are applicable, with strong preference being given to the mechanized methods because of their much greater speeds.

- 3.4.2 Bituminous Materials - Like portland cement, bituminous materials are used extensively for paved surfaces. The two most common finishes are an open-faced surface, possessing a roughened texture to decrease vehicle skidding, and a sheet asphalt finish which has a dense, smooth surface. Sheet asphalt is used mainly for city pavements because the surface is easily cleaned, while the open-faced surface is used on highways and on steep grades because of the better traction its roughness provides.

Newly finished bituminous surfaces are free from joints and can be decontaminated readily by any of the wet or dry methods. When the surfaces age, however, potholes frequently develop and are repaired by bituminous patches which seldom blend completely into the surfaces. Both unrepaired potholes and repair patches constitute obstacles, which will cause "hot spots" to be left after high speed, mechanized decontamination.

- 3.4.3 Brick and Stone Block Pavements - Both of these materials are still found in many communities, principally on steeply graded roads. New surfaces, however, are seldom made with them. Pavement block surfaces are characterized by the exposed faces of the blocks surrounded by joints filled with hot asphalt cement or portland cement grout. Because of the numerous joints, cleaning these pavements is very time consuming. The joints, being depressed below the faces of the blocks, tend to accumulate particles.

The most efficient methods of decontamination are firehosing and street flushing, since the stream pressure will wash the particles out of the joints and flush them away.

3.5 Selection of Method of Decontamination

After the Zone Decontamination leader has determined the characteristics of the paved area, with respect to drainage, slope, crown, size, surface material, and condition, and has considered available equipment and manpower, he should select the decontamination method best suited for the task. Figure 3-E summarizes the surface materials discussed in this chapter and relates them to the several mechanized decontamination methods.

FIGURE 3-E

	Mechanical Sweeper	Vacuum Sweeper	Street Flusher	Firehose
Portland Cement Concrete	A	A	B	C
Bituminous Materials	A	A	B	C
Brick and Stone Block	A	A	B	C

A - Applicable to areas where there is enough space to maneuver.

B - Recommended for pavements less than 100 feet between drains due to accumulated build-up of particles from preceding passes.

C - Recommended for smaller areas or when motorized equipment is not available.

CHAPTER 4

DECONTAMINATION OF NATURAL AREAS

ABSTRACT

The decontamination of natural (unpaved) areas is much less efficient than that of paved areas. However, particularly for buffer zones, varying amounts of it will be required, depending in general upon the degree of urbanization of the zone. Dry methods only are suitable for natural area decontamination, except for limited use of wet methods on hard frozen surfaces.

The basic concepts for decontaminating natural areas are: picking the surface up, pushing the surface away, turning the surface under, and covering the surface over. The methods suitable for these concepts are discussed.

Decontamination is greatly affected by combinations of the factors: slope, vegetation cover, earth composition, and moisture content. These factors and their effects are described. The suitability of the various methods for different conditions is summarized.

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4.1 Scope

Although paved surfaces permit decontamination methods which are far more rapid than are those for unpaved surfaces, the latter represents much of the area which will require decontamination following a nuclear attack. Open spaces and routes intended for occupation will be selected from paved areas and roads, as far as possible, by the Zone Decontamination Planner. However, much natural terrain will require decontamination for Buffer Zones, parking areas for Recovery Operation vehicles if no paved lots are suitably located, and possibly for children's recreation areas during long periods of recovery.

Natural terrain is defined as any land surface not paved with portland cement concrete, bituminous material, or brick or stone blocks. It includes loose or bituminous impregnated gravel roads and shoulders. Typical natural areas, most likely to be included in Buffer Zones, and, therefore, requiring decontamination, will include lawns, parks, tree lawns, median strips, unpaved shoulders, woods, and fields along roadsides. (See Figure 4-A)

- 4.1.1 Decontamination Methods for Natural Areas - Dry methods only are suitable for warm weather natural area decontamination. In cold weather, bare frozen surfaces can sometimes be cleaned effectively by firehosing or flushing.
- 4.1.2 Factors Affecting Decontamination - Almost any conceivable factor affecting the make-up and condition of the terrain will also affect the decontamination operations on it. The various combinations of slope, moisture content, vegetation, and earth composition are essentially unlimited, and may vary widely on the same plot of land. In general, "ideal" characteristics for decontamination of natural areas are:
 - 1. Soil surface free of rocks and large vegetation
 - 2. Soil firm, but not hard
 - 3. Soil moist, but not wet
 - 4. Soil cohesive and of uniform composition
 - 5. Soil surface smooth and flat.

4.2 Concepts of Decontamination of Natural Areas

While only dry methods are applicable, there are four basic concepts for the decontamination of natural areas. They are:

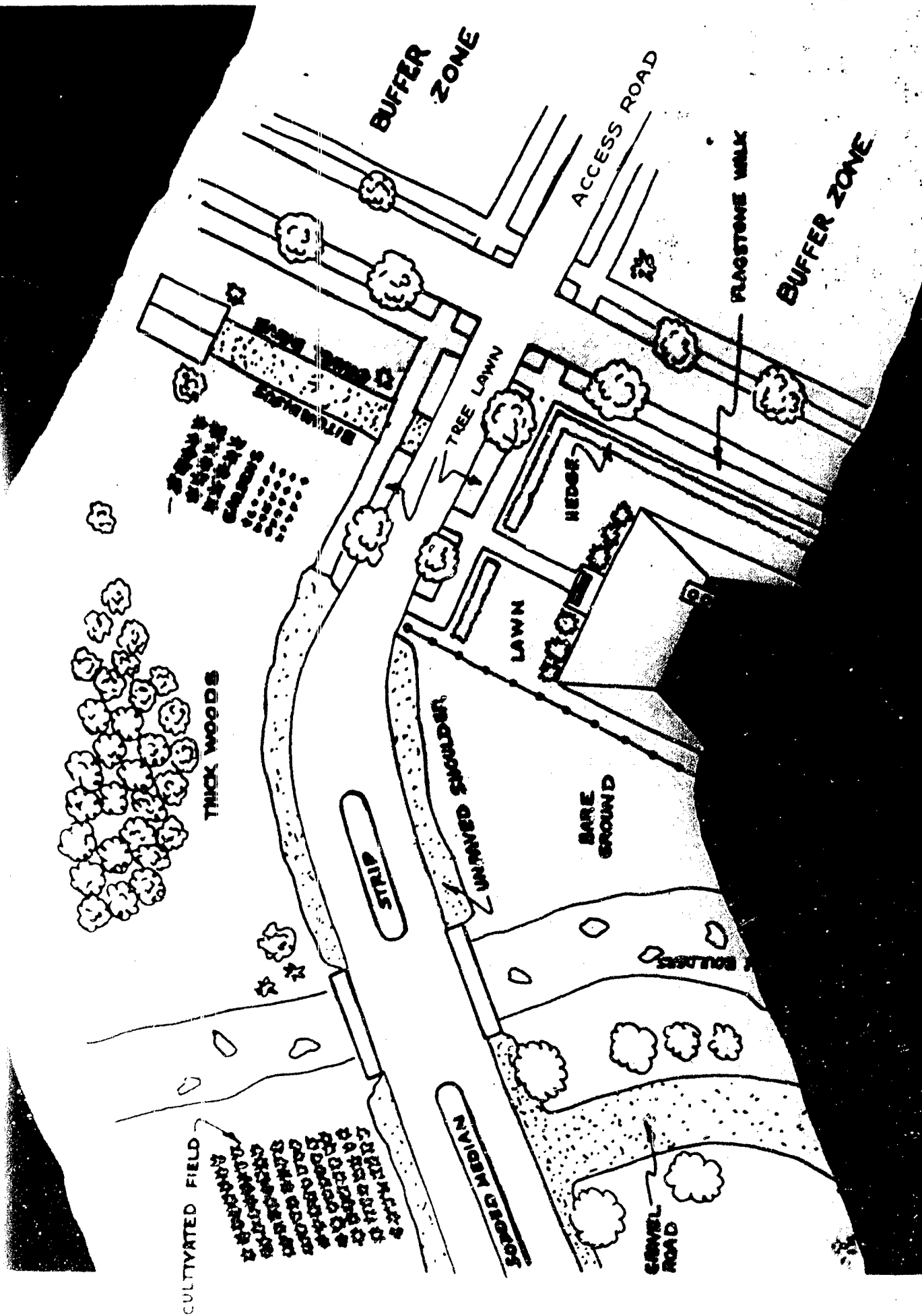


FIGURE 4-A PROBLEMS OF NATURAL AREA DECONTAMINATION

1. Picking the surface up
2. Pushing the surface away
3. Turning the surface under
4. Covering the surface over.

The first two concepts correspond to the basic principle of removing the surface, and with it, the fallout.

The second two concepts correspond to the principle of covering, or shielding, the surface. Since covering does not destroy the radioactivity, it will continue to remain a potential hazard. Anything which disturbs the surface, such as rain, wind, digging, or continuous traffic, may decrease the thickness of the shield, and recreate an active hazard. For this reason, and because effective shielding for anyone directly over the radioactive material will require about three feet of earth, covering and turning-under techniques should be reserved for Buffer Zone decontamination only.

- 4.2.1 Picking-Up the Surface - The objective, in this concept, is to remove the surface of the soil without removing more of it than is necessary. Tests have established that removal to a depth slightly greater than the depth of the surface irregularities will effectively remove the fallout particles. Usually, removal depths of two to four inches will be sufficient. Fissures and cracks which penetrate deeper than this may contain fallout which will remain as "hot spots", requiring manual removal.

Mechanized equipment for surface pick-up includes the motor scraper, which cuts and collects a controlled thickness of earth as it advances. The manual counterpart of machine scraping is hand shoveling into a wheelbarrow or truck. The hand shoveling method should be limited to small or inaccessible areas and to "hot" spot removal.

Experiments have demonstrated the feasibility of decontaminating grass covered lawn by rolling up and removing strips of sod. (See Figure 4-B). A hand propelled sod cutter was used in the experiment, though sod removal using simple manual garden tools can be accomplished. Neither method is as rapid or efficient as mechanically scraping-up the sod.

- 4.2.2 Pushing-Away the Surface (Figure 4-C) - As in the pick-up method, the objective is to remove the particles with a minimum removal of soil. Normally, removal of the top two to four inches of soil is sufficient, and the remaining "hot spots" caused by spillage or fissures can be manually removed.

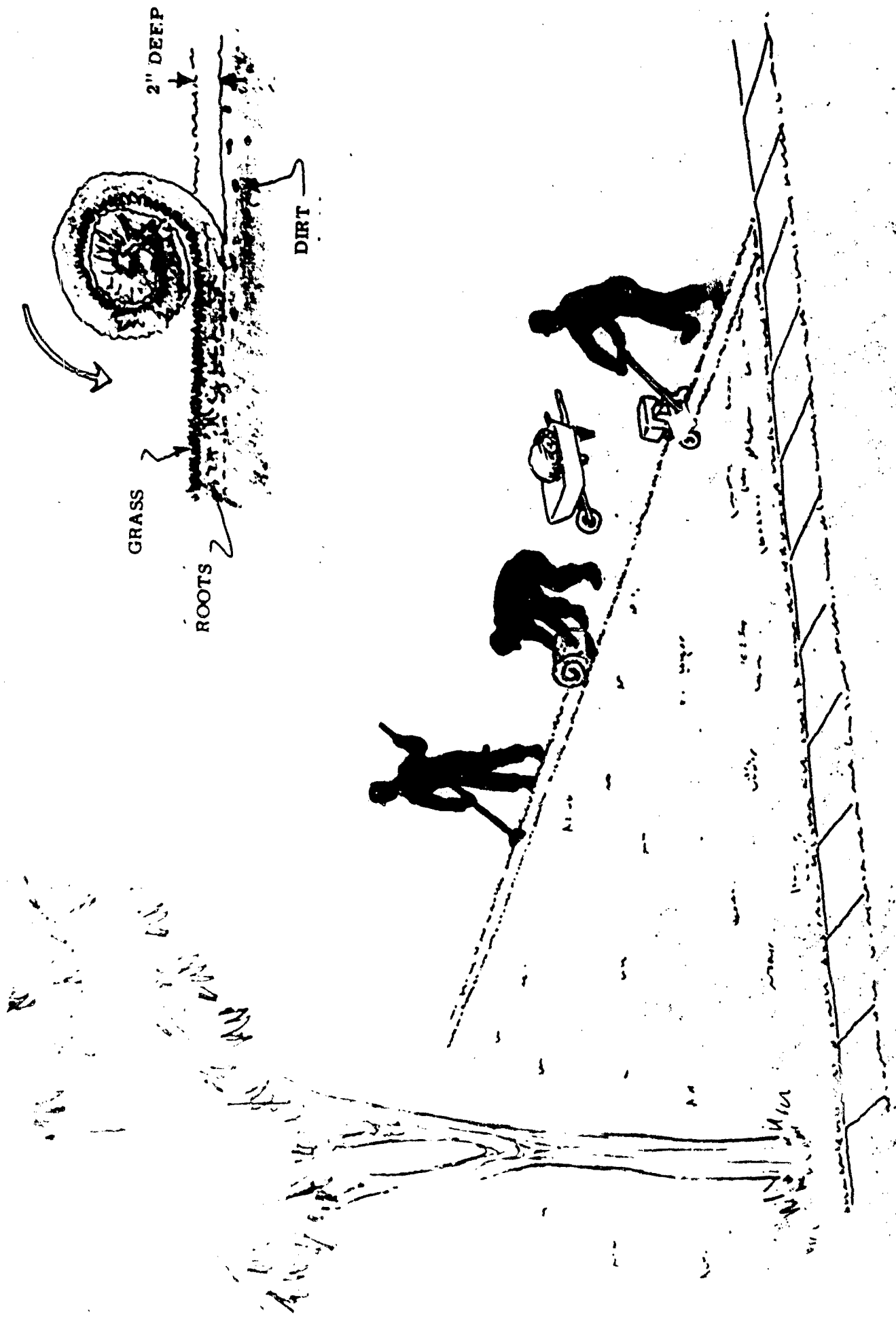


FIGURE 2-B SOD REMOVAL

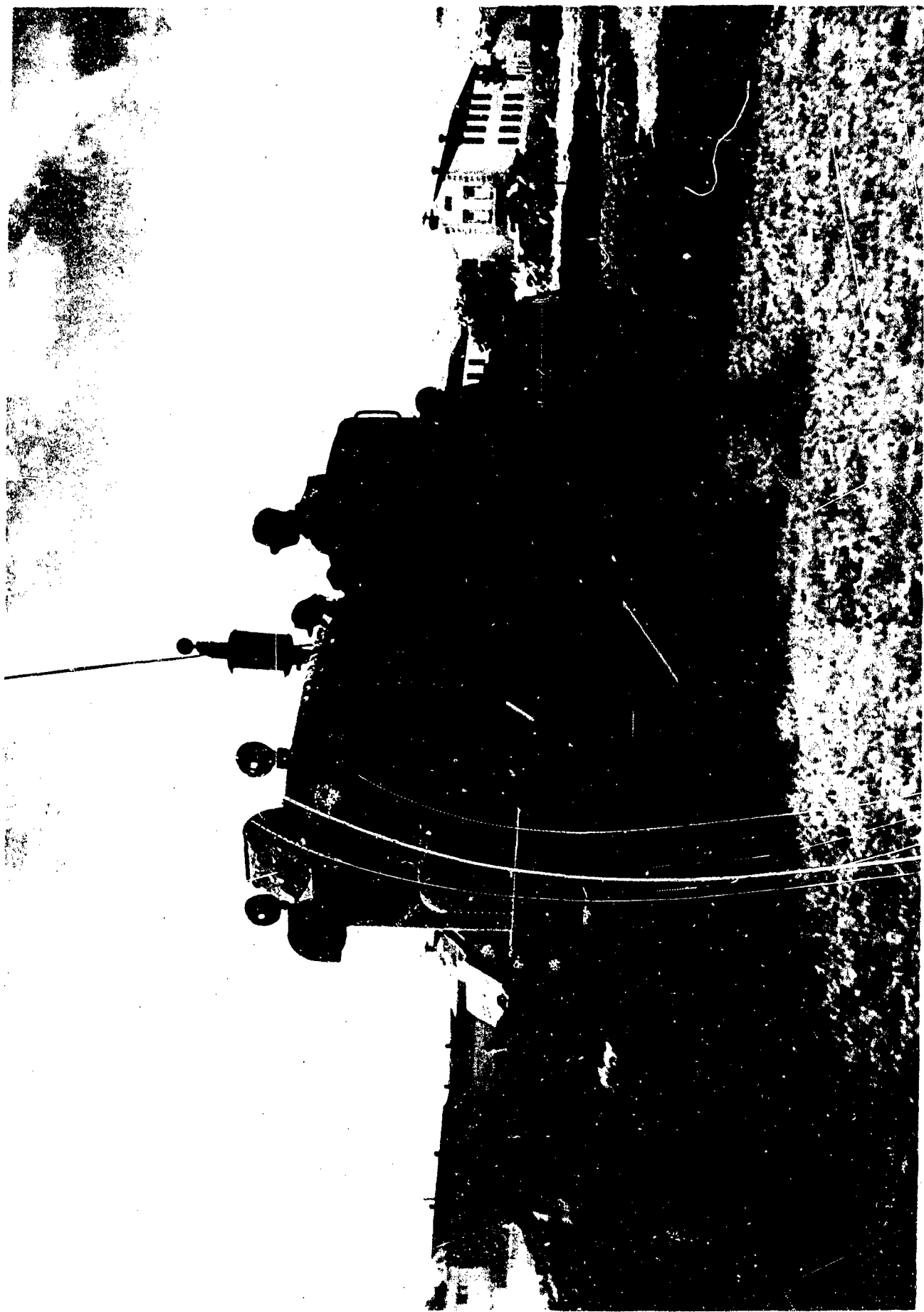


FIGURE 4-C-10 PUSHING AWAY THE SURFACE

Motor graders and bulldozers are employed to push away the surface. The grader advances with its mold board set at an angle, so that a windrow of material paralleling the grader's path, remains. The windrows are then picked up by earth loaders, placed into trucks, and hauled away. Scrapers can also be used to collect the windrows.

Bulldozers operate by pushing the material ahead of them until they reach the edge of the area being cleared. Because of the continual accumulation of material ahead of the blade, the distance the bulldozer can travel without excessive spillage is less than 100 feet.

- 4.2.3 Turning-Under the Surface - A reduction in the above ground radioactivity can be accomplished by turning under the surface on which fallout particles lie and thereby creating a new, clean surface of subsoil.

Plowing the soil is a rapid and effective way of turning fallout particles under. Hand spading is the manual counterpart, but it should be used only on small or irregular areas.

Six to eight inches of soil covering, the practical limit of plowing or spading depth, does not provide a great deal of shielding for the space directly over the buried fallout. It does, however, provide several feet of oblique angle shielding to persons some distance away (Figure 4-D) and is, therefore, an effective technique for Buffer Zone decontamination.

- 4.2.4 Covering the Surface (Figure 4-E) - This concept is similar to that of turning the surface over. The objective is to cover the contaminant with clean soil which has been carried to the site and spread either manually or mechanically. Unlike plowing, the depth of cover is not limited to a few inches. The shielding effectiveness is dependent upon the depth of cover, which in turn is dependent upon the availability of clean soil, equipment, and time. However, adequate direct shielding requires about three feet of fill and is dependent upon this fill remaining in place above the fallout particles. It is probable, therefore, that covering, like turning-under, will be of practical use for Buffer Zone decontamination.

4.3 Characteristics of Natural Areas

Characteristics of natural areas which exert the greatest effect on the selection and performance of decontamination methods are:

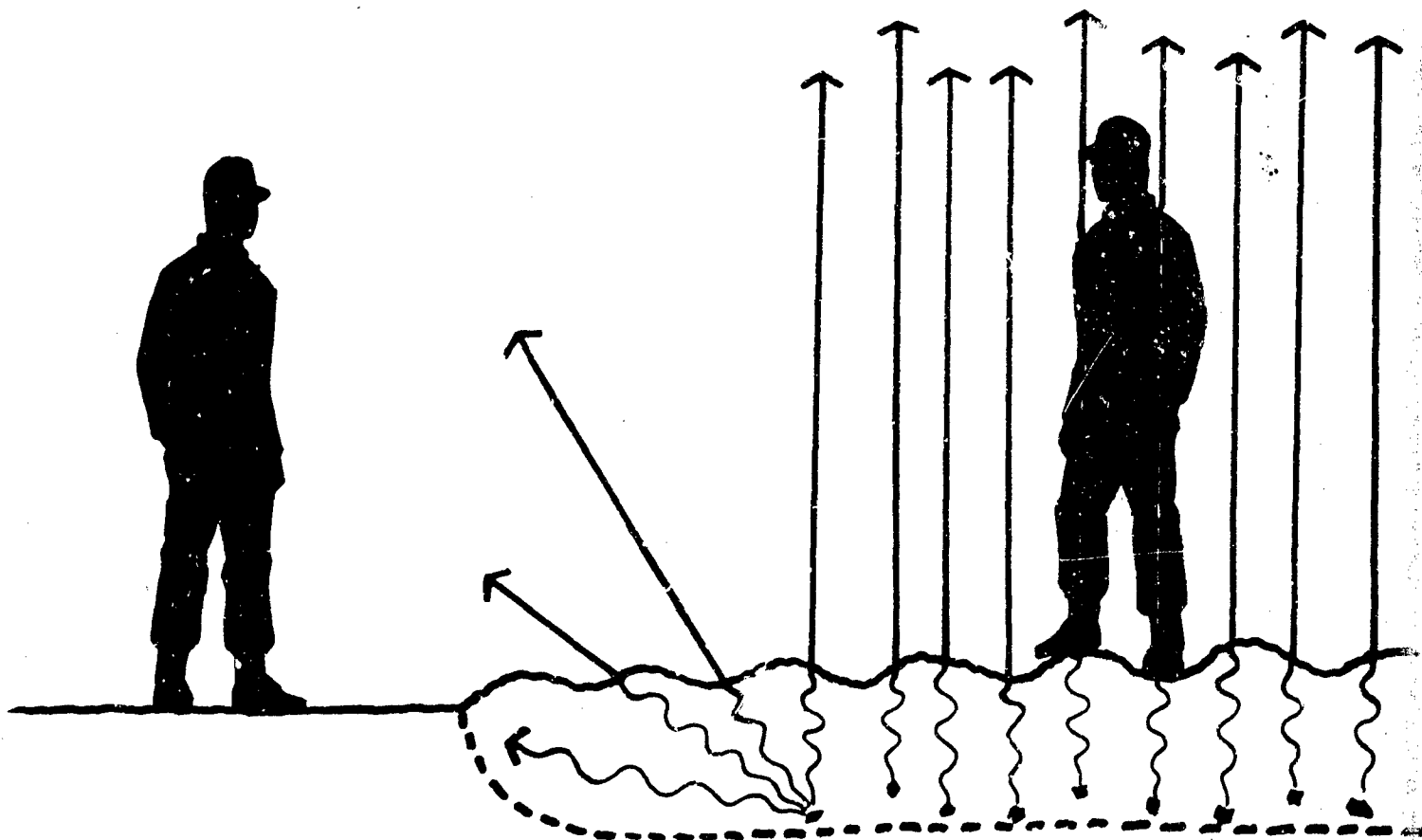


FIGURE 4-D

PLOWED EARTH PROVIDES OBLIQUE ANGLE SHIELDING
FROM RADIATION

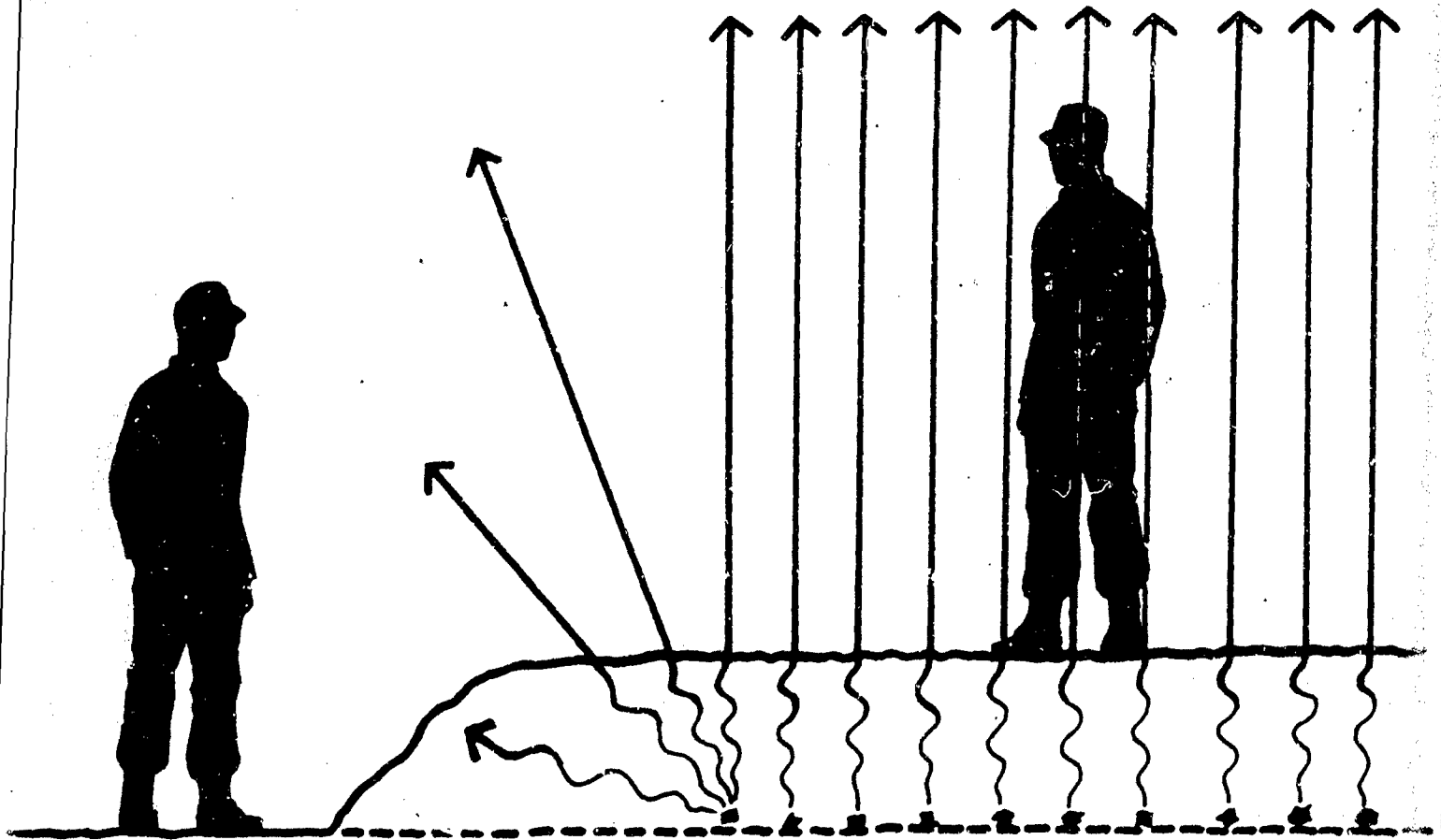


FIGURE 4-E

**FILLING OVER FALLOUT PARTICLES WITH CLEAN SOIL
PROVIDES SHIELDING FROM RADIATION**

1. Slope
2. Vegetation
3. Earth Composition
4. Moisture Content
5. Climate and Season

4.3.1 Slope - The slope of the terrain is important to natural area decontamination if it is steep enough to retard or prohibit the use of motorized equipment. Since only dry methods are involved, this is the only importance of slope. The Zone Decontamination leader, as well as the team captain, should be familiar with the slopes in his territory to avoid assigning impossible decontamination tasks to machines which could better be employed elsewhere.

4.3.2 Vegetation - Removing vegetation can be an important factor in decontamination of natural areas. Grass, weeds, cultivated grain and vegetable farm acreage present no difficulty. They are easily uprooted and removed with the top soil layer by any of the decontamination methods. On the other hand, bushes, shrubbery, and underbrush require more careful consideration, since manual picking-up or turning-over methods, as well as plowing and scraping, cannot cut through the growth. The vegetation must first be cut down, or up-rooted, and removed in an additional operation. Covering methods also, require prior removal of the vegetation.

Trees represent the most serious decontamination problem of any vegetable growth. Their leaves and branches may collect large amounts of fallout, and their trunks and roots will hamper the use of large ground decontamination equipment.

Single trees, standing in isolated locations, can, perhaps, be decontaminated satisfactorily by firehose lobbing. Even this is questionable, in some cases however, due to the tremendous surface area of a tree in foliage and to the stickiness of the leaves and roughness of the bark on some trees. The operation would be very time consuming, at best. Trees in groups, as in thickets and woods, however, cannot be decontaminated.

In extreme cases, if wooded areas must be cleared of fallout, it may be advisable to cut down and haul away the trees before other decontamination operations are undertaken. The stumps and root systems will remain as obstacles. However, particularly in the summertime, the trees will have provided protection from fallout for the ground underneath them, and complete removal of the surface close to the stumps may not be necessary. Where fallout does occur close to the tree stumps and the area being cleared

is in a Buffer Zone, covering the ground with clean earth fill may be employed. In felling trees, care should be taken to avoid breaking power and telephone lines which are required for essential service and communication functions.

Under no circumstance should burning of fallout contaminated vegetation be undertaken in order to clean the area. The heated air will rise, carrying the lighter fallout particles with it and spread them over the surrounding countryside.

- 4.3.3 Earth Composition - Variations in earth composition commonly occur even within small areas. Such variations can have an important effect on the effectiveness and speed of decontamination operations.

It will not always be possible to judge the earth composition before beginning decontamination operations. Such knowledge will be useful to the Zone Decontamination leader, however, to assist him in choosing decontamination methods and equipment. It should be determined, in a general way, for the entire Zone during pre-attack preparation. Consultation with municipal engineers and construction firms may be helpful.

Earth composition, as it affects decontamination, is categorized in the following paragraphs.

- 4.3.3.1 Non-cohesive Soils - These soils tend to slide off of the blades of graders and bulldozers and to disintegrate, rather than turn over, when plowed. They can be decontaminated most effectively by picking-up the surface or by covering it with clean fill.
- 4.3.3.2 Cohesive Soils - Cohesive soils, and soils containing vegetable root systems which act cohesively, are readily decontaminated by pushing-away and turning-over operations, as well as by picking-up and covering.
- 4.3.3.3 Soils Containing Boulders - Boulders (rocks with at least one dimension greater than eight inches) interfere with the operation of plows and graders. Bulldozers and scrapers can remove all but the largest boulders, and their use is recommended. For Buffer Zone decontamination, covering with clean fill is suitable.
- 4.3.3.4 Filled Land - Reclaimed swamp and marsh land, filled with refuse, cinders, slag, and excavated earth, should be treated as non-cohesive soil containing boulders. The surface may be scraped or covered with additional fill.

4.3.3.5 Exposed Rock Formations - The surfaces of rock outcroppings are not suitable for removal by any practical motorized method. Hand shoveling of soil cover and firehosing of the exposed rock may be used. Covering with fill or shielding behind earth dikes is suitable for Buffer Zone areas.

4.3.4 Moisture Content and Climate - It is not possible to foresee the moisture content of the earth at the time decontamination will be required. Soils which may be easy to decontaminate during periods of normal rainfall may cause much more difficulty if an unusually wet or dry spell has preceded the attack.

As an example, clayey soils which are suitable for most methods of decontamination when they contain their usual amounts of moisture, become plastic and sticky when saturated. Equipment will bog down, and decontamination time may be greatly increased.

On the other hand, the same clay soil, when very dry, may become hard and full of cracks and fissures which will trap fallout particles. It may have lost its cohesiveness and no longer be suitable for scraping, pushing, or turning-over.

If freezing weather occurs and continues in the presence of moist earth, the frozen layer will become thick enough to interfere with most of the decontamination methods. Even bulldozing and scraping may be impossible on hard-frozen ground.

When the surface is smooth and hard-frozen, the dry methods suitable for pavement can be used. If the temperature is not far below the freezing point, firehosing may be useful. It should be noted, however, that a glaze of ice over the fallout particles will greatly complicate the decontamination task. The special problems associated with cold weather decontamination are discussed at length in Chapter 5.

This brief discussion of moisture content indicates some of the effects of weather on natural area decontamination. Since many variables are involved and since weather and climatic conditions are beyond control, the special problems posed by moisture and temperature must be faced by the Zone Decontamination leader and the Decontamination Team members when and where they occur.

4.4 Selection of Method of Decontamination

Selection of the several methods required for decontamination of a large and varying natural area is the responsibility of the Zone Decontamination leader and the Decontamination Teams themselves. The leader and team captains should become familiar, prior to a nuclear attack, with the unpaved terrain for which decontamination is planned.

Composition of the soil and its reaction to moisture should be understood. Locations free of boulders and rock, where deep excavations for clean fill can be made, should be noted.

Figure 4-F summarizes the earth compositions discussed in this chapter and relates them to applicable methods of decontamination. Earth composition, as well as surface condition and vegetation, can vary greatly in even a small area. Combinations of methods, therefore, will often be required to decontaminate a natural area completely.

FIGURE 4-F

DECONTAMINATION METHODS FOR VARIOUS SOIL CONDITIONS

Soil Types	Preferred Methods	Applicable, but not Preferred	Not Recommended	Not Applicable
Non-cohesive Soils	Motor Scraper Plow	Motor Grader	Fill	Firehose and Shovel
		Motor Grader with Pick-up Equipment Bulldozer		
Cohesive Soils and lawns	Motor Scraper Motor Grader Motor Grader with Pick-up Equipment Bulldozer Plow	Shovel and Wheelbarrow	Fill	Firehose and Shovel
		Shovel and Wheelbarrow		
Soils Containing Boulders	Motor Scraper Bulldozer	Fill Shovel and Wheelbarrow	Motor Grader Motor Grader with Pick-up Equipment Plow	Firehose and Shovel
		Shovel and Wheelbarrow -to remove soil cover Firehose and Shovel -to clean outcroppings		Motor Scraper Motor Grader Bulldozer Plow
Exposed Rock Formations	Fill			

CHAPTER 5

COLD WEATHER DECONTAMINATION

SUMMARY

Cold-weather weather adds critically to the hardships caused by fallout from nuclear attack. Precipitation, as snow or freezing rain and sleet, greatly increases the problem of decontamination.

Combinations of fallout and winter conditions are divided into five basic conditions which require separate consideration. The characteristics of each condition are described, and applicable methods are suggested. The special problems associated with the wintertime decontamination of roof areas are discussed.

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5.1 Cold Weather in the United States

Figure 5-A shows the portion of the United States which experiences below freezing temperatures at least ten percent of the time during December, January, and February. It also shows the area that receives one or more measurable snowfalls each year. This figure illustrates that a very large percentage of the country is affected by cold weather, and that consideration of the effects of cold weather are important to a high percentage of Decontamination Planners.

The presence of below freezing temperature increases the difficulty of decontamination operations. The addition of snow and ice still more seriously affects and limits the procedures which can be used effectively. As with normal, peacetime activities, however, planning and preparation can be of great help in minimizing the increased difficulty due to weather.

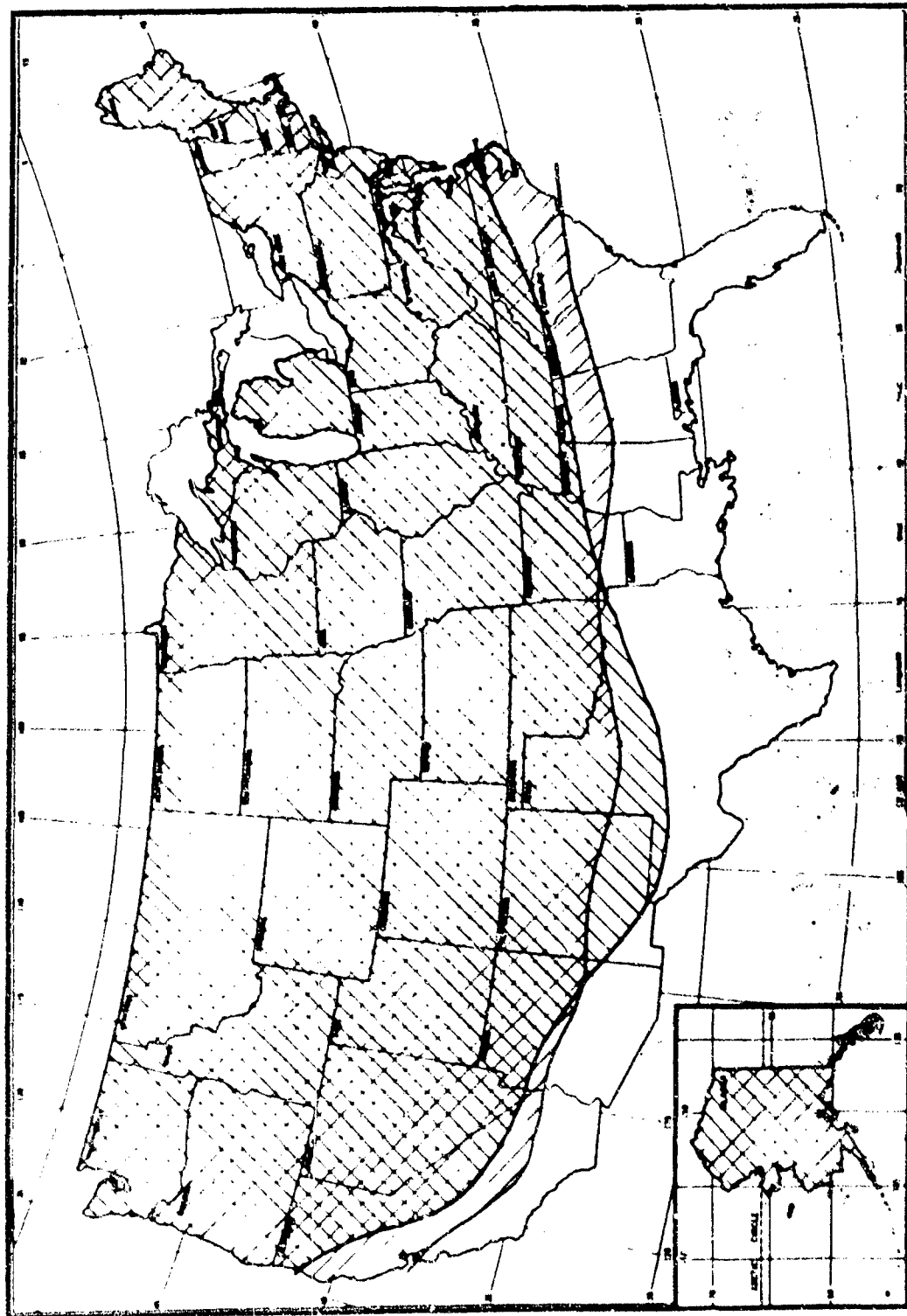
5.2 The Effect of Cold Weather on Decontamination

The specific effects of cold weather on decontamination can be grouped in the following four categories:

1. Freezing, snow, and ice increase the difficulty of removing fallout particles.
2. The techniques are sufficiently difficult to require special training for the teams.
3. Equipment requires special maintenance provisions - anti-freeze, winter lubrication, chains or snow tires, etc. It is subject to motor starting troubles, and consumes more fuel than in warm weather.
4. The teams and equipment are limited to slower rates of advancement and require more frequent rests and servicing.

5.3 Cold Weather Equipment Care

Since the use of motorized equipment is of vital importance to successful decontamination, it is imperative that the maintenance personnel have their vehicles in winterized condition before the first freeze, and before the nuclear attack. Special cold weather equipment and supplies should be available, such as skid chains, ballast for traction, sand or cinders, rock salt, light lubricants, booster cables, battery chargers and spare batteries, and extra anti-freeze.



Below freezing 10% or more of time in months of December, January, and February

Receives measurable snowfall each year

Figure 5-A COLD WEATHER IN THE UNITED STATES

5.4 Weather Data

In order to determine if cold weather preparation is necessary, the Zone Decontamination leader and his team captains should become familiar with the Weather Bureau records for the area and with the experience of local municipal and commercial transport and trucking operators.

5.4.1 Ice - Freezing rain and sleet present the most serious cold weather decontamination problems. Fallout particles encased in a layer of ice may be very difficult to remove.

In areas where ice is apt to occur and stay, the Zone Decontamination leader should make certain his teams are especially well prepared to carry out decontamination operations under icy conditions.

5.5 Cold Weather Decontamination Methods

The many combinations of time of fallout arrival, time of precipitation, and temperature pattern can result in a wide variety of decontamination problems, requiring a wide variety of solutions. In order to cover the whole subject of cold weather decontamination in this chapter, the combinations are separated into five general classes of conditions.

5.5.1 Condition 1 - Loose Fallout Lying on a Hard Frozen Surface -

This condition may result from the occurrence of the fallout event following a dry-cold period where all of the surfaces are frozen but clean. It may also result from the deposit of fallout on packed snow or ice. In all cases, in Condition 1, no precipitation follows the fallout event, and the temperature remains below freezing throughout the period.

The choice of decontamination method must be guided by the fact that the frozen surface is extremely hard, thus eliminating the use of bulldozers or other equipment that pick up or push away the surface. In addition, methods utilizing water may not be effective since the surface temperature may freeze the run-off water and trap the particles before they reach the drainage points.

Mechanical sweepers, vacuum sweepers, and manual sweeping methods are not seriously affected by the low temperature and are recommended when the ground is frozen hard and the fallout particles are loose.

- 5.5.2 Condition 2 - Fallout Encased in a Layer of Ice - This condition can result if fallout is followed by a freezing rain, or if the fallout particles fall on an iced surface which subsequently melts and re-freezes. The major problem is that the fallout particles are encased in the ice. In order to remove the particles, the ice must be removed as well.

The methods available for removing ice entrapped fallout are extremely limited in application. It is possible that, if the ice layer is thin, the temperature not too cold, and with good slope and drainage, firehosing may melt the ice and remove the particles. The slope required for fast drainage will present a hazard to the operations of the Decontamination Team. Rock salt may assist in melting the ice so that firehosing is more easily accomplished.

Another method which can be used, is manual ice-chopping. The method is extremely slow and should be used on small areas where other methods are not available. Ice-choppers should not be used on roof surfaces since damage to the roofing material can result in leakage of water and fallout particles into the building.

The problem of removing ice layers from the roofs of buildings can be reduced if the internal heating system is used to raise the temperature inside the building to a point where it will melt the ice.

- 5.5.3 Condition 3 - Loose Fallout on a Hard Frozen Surface, Covered By a Layer of Snow - This condition is similar to Condition 1 except that in addition to removing the fallout particles, the snow layer must also be removed. It will result from the accumulation of fallout particles on frozen ground, packed snow, or ice, followed by a snowfall. The temperature throughout the entire period remains below freezing.

The choice of decontamination method is dependent upon the depth of snow cover. For depths of less than three inches, it may be possible to hose, if sufficient slope and drainage are available to carry the volume of run-off without re-freezing.

Mechanical sweepers and vacuum sweepers can be used where the depth of snow is not greater than about two inches. Hoppers fill rapidly and require emptying at frequent intervals when the snow is deep. Manual sweeping is also possible. Snow accumulation ahead of the operators can be removed with hand shovels and wheelbarrows or trucks. Sweeping will be most effective when the depth is shallow and the snow is dry.

Snow plows, motor graders, scrapers, and other machines that scrape or pick up the snow may be useful for removing the snow cover. They cannot cut into the frozen surface to remove the fallout, which must be done by mechanical or hand sweeping or firehosing.

- 5.5.4 Condition 4 - Fallout Particles Entrapped in Ice, Covered by a Layer of Snow - This is a combination of Conditions 2 and 3 which further complicates the problem of decontamination. It may result if fallout is followed by a freezing rain, which in turn is followed by snow; or if the fallout particles fall on an iced surface, which subsequently melts, re-freezes, and then receives a snowfall.

If the ice layer is thin and the snow cover shallow, firehosing may be useful as a decontamination method. In this situation, the problem of roof decontamination may be alleviated by raising the internal temperature of the building to assist in melting the ice and snow on the roof.

If the ice layer is covered by deep snow, it will be necessary to remove the snow prior to decontaminating the iced surface. Snow removal may be effected by snow plows, motor scrapers, hand shoveling, etc., in accordance with the size of the area the depth of the snow, and the equipment available. Once the ice layer has been exposed, the decontamination of the surface can be accomplished by salting the surface, firehosing, ice-chopping, or, in the case of roofs, elevating the internal building temperature.

- 5.5.5 Condition 5 - Fallout Particles Intermixed with Snow - This condition results from fallout occurring during or after a snowfall. The fallout can be intermixed throughout the entire depth, occur at any level within the depth, or it can lie entirely on the top surface.

The major considerations for decontaminating areas upon which fallout, intermixed with snow, has fallen are:

1. The depth of the snowfall
2. The location of the fallout particles within the depth.

As the depth of snow increases, the volume that must be removed increases, requiring additional man and equipment hours.

The location of the fallout particles within the layer of snow also affects the effort required for its removal. If all of the fallout is located on the top surface of the snow, it can be removed by skimming the upper few inches. As the depth of the fallout below the surface increases, the volume of snow that must be removed likewise increases.

The choice of decontamination methods for depths less than three inches can be considered independently of the location of the fallout particles. Firehosing may be used to wash the snow and fallout particles away, provided that sufficient slope and drainage are available to carry the volume of run-off without danger of re-freezing.

Mechanical sweepers, vacuum sweepers, or manual sweeping are also effective, especially when the depth of snow is shallow and the snow is dry and powdery.

As the depth of snow increases, the location of the fallout particles within the snow layer becomes more important. Snow plows, motor graders, motor scrapers, and other equipment that scrape or pickup the snow from the surface are effective as long as the particle location is more than a few inches above the ground surface so that the blade can cut below them. As the depth of particles below the top surface decreases, the depth of cut decreases, resulting in the removal of less snow and in greater equipment speed.

5.6 Roofs of Structures

Roof surfaces of structures require special consideration for decontamination in cold weather. The presence of ice or snow on sloped roofs prevents standing or walking on them. Run-off water from firehosing operations may freeze and glaze roofs. Drains may plug with ice or slush and prevent run-off of fallout-laden water.

When roofs are flat or have low slopes, hand brooming is effective, if the surfaces are bare or have only a light covering of dry, powdery snow. The method is slow but relatively safe for the Decontamination Team. Where the snow cover is thicker, hand shoveling plus sweeping will be required, and greater care must be exercised to prevent slipping and falling on snow which has packed under the team members' feet.

On steeply sloped roofs covered by ice or snow, firehose lobbing is the only practical decontamination method. This method may be limited to temperatures not too far below freezing, since water, freezing as it strikes the roof, will encase the fallout particles in a sheet of ice and prevent their dislodgement.

The building's heating system can sometimes be utilized to assist in roof decontamination. By raising the internal temperature of the top floor, the roof may be heated to above freezing. This will prevent glazing from run-off water and will melt ice which has already formed. Flat and low sloped roofs can then be firehosed safely, and steep-sloped roofs can be lobbed.

Heating of the roof will be greatly accelerated by removal of any interior roof insulation. The roof temperature should be maintained high until all decontamination has been completed, to prevent refreezing of run-off water.

Ice-choppers and spiked shoes should not be used on roof surfaces, as they may cause leakage of water into the building. Salt may be used on icy roof surfaces to assist melting.

5.7 Selection of Decontamination Method

Figure 5-B is a summary of the various condition categories and of roof surfaces in terms of the decontamination methods suitable to them. Once the Zone Decontamination leader has ascertained the weather and surface conditions in his Zone, this chart will be of assistance in helping him select the best cold weather cleaning methods for the different surface areas.

FIGURE 5-2 - SUMMARY OF COLD WEATHER DECONTAMINATION METHODS

	CONDITION 1 LOOSE FALLOUT ON HAUD FROZEN OR PAVED SURFACE	CONDITION 2 FALLOUT ENCASED IN LAYER OF ICE	CONDITION 3 LOOSE FALLOUT ON HAUD FROZEN OR PAVED SURFACE, COVERED BY SNOW	CONDITION 4 FALLOUT ENCASED IN ICE, COVERED BY SNOW	CONDITION 5 FALLOUT INTERMIXED WITH SNOW	ROOFS OF STRUCTURES
Hand-broom Sweeping	Good	N/A	Good, after initial removal of deep snow cover or where snow layer is less than 2 inches thick.	N/A	Applicable, if depth of snow is less than 2 inches and snow is dry.	N/A
Hand-broom Sweeping	Good	N/A	Pair, after initial removal of deep snow cover or where snow layer is less than 2"	N/A	Applicable, if depth of snow is less than 2 inches and snow is dry.	N/A
Motor Grader	N/A	N/A	Applicable only for removal of snow cover exposing fallout particles.	Applicable for removal of snow cover exposing ice layer	Pair	N/A
Firehosing	Pair - Good	May be used if ice layer is thin. Salt may be used to assist melting.	Pair to good, after initial removal of deep snow cover or where snow layer is less than 2".	May be used where ice layer is thin after initial re- moval of snow cover. Salt may be used to assist melting.	Good, if snow depth is less than 2 or 3 inches.	Good, if roof is warmed by internal heating. Use lobbing technique if slope is steep.
Blade Snow Plow	N/A	N/A	Applicable only for removal of snow cover ex- posing fallout particles.	Applicable for removal of snow cover exposing ice layer.	Good	N/A
Motor Scraper	N/A	N/A	Applicable only for removal of snow cover ex- posing fallout particles.	Applicable for removal of snow cover exposing ice layer.	Good	N/A
Hand-broom Sweeping	Good	N/A	Good, after initial removal of deep snow cover or where snow layer is less than 2 inches.	N/A	Good, if snow depth is less than 2 or 3 inches.	Good, for dry, light snow on flat or low slopes. Use with hand shoveling where snow depth exceeds 3 inches.

CHAPTER 1

101 DECONTAMINATION METHODS

ABSTRACT

For decontamination operations are often carried out by fire-fighting teams and motorised street flushers. Chapter 1 contains separate sections for these two methods, intended to be used by the team members independently of the remainder of the manual. Personnel and equipment requirements, operating procedures, and the various applications which will be encountered in radiological decontamination are covered.

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6.1 Scope

The wet decontamination methods, those involving the use of water as the principle means of removing fallout particles, are grouped in this chapter. Team make-ups, equipment requirements, and operating instructions for various applications are shown. The manual and motorized methods, since they involve different equipment and personnel with different skills, are included as separate sections of the chapter. They will be found helpful as operating instructions for the Decontamination Teams and may be used independently of the Manual by removing them, or by obtaining separately printed pages.

6.2 Principles of Wet Decontamination

The wet methods are among the most effective means for decontaminating hard, coherent surfaces, such as roofs and pavement. The methods include firehosing, firehose lobbing, and motorized street flushing. In principle, firehosing and flushing rely on high velocity water streams, which loosen the fallout particles and accelerate their natural drainage from high areas toward low areas and drainage points. Lobbing, recommended for steep roofs, relies less upon impingement velocity than upon the washing action of the water as it runs rapidly down the steep surfaces.

6.3 Manual and Motorized Wet Methods

Chapter 6 includes a section on manual firehosing and a section on motorized street flushing.

The firehosing section contains the following method application instructions:

1. Firehosing - Tar and Gravel roofs
2. Firehosing - Roof Surfaces Other Than Tar and Gravel
3. Lobbing on Roofs
4. Firehosing - Paved Areas
5. Firehosing and Hand Shoveling - Natural Areas
6. Firehosing - Cold Weather

The street flushing section contains instructions for:

1. Conventional Street Flusher
2. Improvised Street Flusher

TEAM MEMBERSHIP

The team should consist of seven members, including a captain, each able to perform all team functions. The functions include connecting and handling high pressure hose and high capacity water pumps, climbing ladders, and walking on roofs. Men with such skills can be found in fire departments and on board ships. The individual functions, to be assigned as required, are:

Nozzle man (2)	-Handles nozzle and directs high velocity spray on surfaces to be cleaned
Hose man (2)	-Handles and moves high pressure hose
Pump man	-Makes connections to hydrant, pump, and lines and operates high pressure, high capacity pump
Shovel/Wheelbarrow man	-Picks up accumulations of gravel, dirt, and slush; keeps drains clear; and removes "hot spots".
Vehicle driver	-Tows the 2-1/2 inch hose over large areas and transports team and equipment to work sites.

EQUIPMENT

The team should be prepared to handle a variety of jobs without additional help, including paved areas, rock outcroppings in parks, and both flat and steep roofed buildings.

The required equipment for a seven man team is as follows:

1. One 500 gpm pump with 2-1/2 inch firehose connections, to maintain constant, adjustable nozzle pressure of 40 to 150 psi - For Zones which rely on ponds or streams for fire fighting water, the pump should be suitable for drawing water from these sources.
2. Two lengths of 2-1/2 inch firehose, for pump suction and discharge. The hose lengths should be sufficient to reach any part of the Zone from a water source and to carry to the roof of any building.
3. One 2-1/2 inch by 1-1/2 inch by 1-1/2 inch "Y" fitting
4. Two lengths of 1-1/2 inch firehose
5. Two standard fire nozzles with 5/8 inch orifices
6. Two long handled shovels
7. One wheelbarrow
8. Ladders, ropes, pulley blocks, etc., for gaining access to roofs of buildings; prybars and other tools to remove gutters and drainspouts
9. Wrenches, other tools, spare equipment, extra fuel, etc., necessary to connect, operate, and field maintain the decontamination gear
10. One jeep or other vehicle to transport the team and equipment and to tow the 2-1/2 inch hose line during decontamination of large areas.

PRINCIPLE OF OPERATION

Firehosing utilizes the force of a high velocity water jet to dislodge and wash away radioactive fallout particles. It is a manual operation and is especially useful on roofs and other surfaces which cannot be decontaminated by mechanical means.

TYPES OF SURFACES

Firehosing can best be used for decontaminating the following types of surfaces:

1. Roofs
2. Pavement, especially small or irregular areas containing obstructions
3. Washing-down gutters and flushing drains after motorized street flushing
4. Exposed rock formations, assisted by hand shoveling where earth deposits are scattered in and around the rock outcroppings
5. Bare and lightly snow covered frozen ground, especially small or irregular areas containing obstructions.

ADVANTAGES

Firehosing equipment has the advantage of being readily available. Its flexible character permits it to be transported easily on the ground, carried to roof-top by ladder, and moved about on the roof surface. The method is particularly effective in decontaminating around obstructions. Although operations at roof-top level are hazardous, the technical skills required for firehose decontamination are not difficult to learn, and inexperienced workers can be trained quickly.

GENERAL INSTRUCTIONS

Firehosing operations are begun by setting up the pump, connecting the suction line from the hydrant or other source, connecting the discharge line to the "Y" fitting, and connecting the branch lines from the "Y" to the nozzles.

Cleaning starts at the highest point and proceeds downward toward the drains or edges. Drains should be checked and kept clear. Movable obstructions, including roof gutters and timbers used as bumpers in parking lots, should be removed.

Firehosing requires high pressure water to be effective, especially on flat or low-sloped surfaces. The steeper the slope, the less important water velocity becomes.

The stream should be directed at the surface 15 to 20 feet away. To dislodge particles from crevices and around obstacles, this distance may be shortened. When the accumulation of loose material ahead of the stream, including fallout particles, becomes excessive and difficult to move by the force of the water, it should be picked up by hand shovel and carried away in a wheelbarrow or other conveyance, (Figure 6-A).

GENERAL INSTRUCTIONS (continued)

"Hot spots" remaining after decontamination are located either visually or by radiation instruments and marked. The team should clean these up, either by further firehosing or by shoveling or sweeping. Drains and gutters should be flushed after completion of surface decontamination. Trenches and sumps, dug to receive run-off water, should be backfilled.

Contaminated debris and soil, shoveled into the wheelbarrow, should be dumped at a pre-selected site. This should be downwind and preferably behind a natural or prepared barrier or into an excavated ditch.

It is expected that maintenance crews, composed of personnel other than members of the Decontamination Teams, will repair and service equipment during hours when the teams are off duty. However, each team is dependent on the reliable functioning of its own gear and should, therefore, make certain that it is kept in perfect condition and has sufficient fuel, oil, water, etc. for each day's operation.

SAFETY CONSIDERATIONS

Electric power lines - Before starting firehosing, cut all electrical power to buildings. Do not play water on power lines and transformers. These may be activated and can cause electrocution of team members and damage to equipment.

Roof decontamination - Ladders, rope lines, etc., should be checked for condition prior to use. Roof surfaces, eaves, overhangs, gutters, and other roof features should be checked for strength prior to placing equipment or personnel on them. Steep and slippery roof surfaces require special precautions to prevent falls. Securing of ladders may be necessary for personnel safety. Lashing of the hose may be necessary to prevent whiplash and sliding of the hose off of the roof.

High Velocity water - High pressure hose streams directed against windows, louvers, ventilators, brittle roof tile, etc., can cause damage. Such streams directed against personnel can cause serious injury. On roofs, workers struck by firehose streams may lose their balance and fall off. Nozzles should not be aimed directly at the contaminated surface, as this will splatter the particles in all directions, back over the area already cleaned, on fellow team members, and on the nozzle holder himself. (See Figure 6-B)

APPLICATIONS OF FIREHOSE DECONTAMINATION

The following pages contain specific instructions for six applications of firehose decontamination which the team may be called upon to perform. These instructions should be considered as supplemental to the general instructions and safety considerations discussed above.

FIREHOSING - TAR AND GRAVEL ROOFS (Figure 6-C)

Special Comments - Tar and gravel roof surfaces differ from other roofs in the amount of loose material that will accumulate in front of the firehose stream. The loose gravel, intermixed with fallout particles, will pile up to such an extent that it will require periodic removal by hand shoveling. This type of surface is most commonly found on flat roofs. However, it will also be found on low slopes, up to about 3-on-12. The flatter the slope, the more loose gravel will accumulate on it, and the more frequently the accumulation will require removal by shoveling.

FIREHOSING - TAR AND GRAVEL ROOFS (continued)

A modification of the tar and gravel roof, which may require special treatment for decontamination, is the loose marble chip roof. This type of surface is popular in the Southwest and is also being used on new structures in other parts of the country. Basically it is a tar and gravel roof, of 1-on-12 or lower slope, with up to an inch or more of loose marble chips spread over it. A metal lip or gravel stop will usually be found around the edge. It is doubtful if firehosing alone can be used effectively on such loose gravel roofs. It is recommended instead that the metal gravel stop be bent down and the roof shoveled or swept free of loose gravel before firehosing. The gravel should be deposited in a truck for removal from the area, or in a hole or trench for covering with clean earth.

Procedure

1. Check drains for clogging, remove gutters, and bend down gravel stops, where necessary, for adequate drainage. Provide for removal or covering of fallout washed from the roof edges onto the ground. Dig drainage trenches or sumps as required.
2. Set up pump and hose lines.
3. Divide roof into quadrants and begin hosing from high points down. Adjust pressure to 120 psi.
4. Protect interior drains and valleys from accumulation of loose gravel, to prevent clogging. Remove gravel and fallout particles by hand shovel and wheelbarrow as they build up. One man with shovel and wheelbarrow will be required to keep up with each firehose nozzle.
5. Flush drainage system after firehosing.
6. Clean up "hot spots".
7. Backfill trenches and sumps on the ground.

Rate of Operation - The firehosing team should advance at approximately 250 square feet per minute, not including set-up or moving time, or rest periods. This rate will vary with the number of obstructions, the quantity of loose gravel, and the amount of fallout.

FIREHOSING - ROOF STRUCTURES OTHER THAN TAR AND GRAVEL (Figure 6-D)

Special Comments - Firehosing should, in general, be limited to roofs with slopes below 3-on-12. Surfaces other than tar and gravel, for such roofs, will include promenade tile, exposed concrete, macadam roll-roofing, sheet metal, shingle and tile. Little loose material will be encountered, and shovels and wheelbarrows will not be required, except, perhaps, on flat roofs of very large area.

Procedure

1. Check drains for clogging, remove gutters where necessary for adequate drainage. Provide for removal or covering of fallout washed from the roof edges onto the ground. Dig drainage trenches or sumps as required.
2. Set up pump and hose lines. Adjust pressure to 120 psi.

FIREHOSING - ROOF STRUCTURES OTHER THAN TAR AND GRAVEL (continued)

3. Divide roof into quadrants and begin hosing from high points down. Direct hose with the lap to avoid lifting shingles or lapped sheets and driving particles under them. (See Figure 6-B)
4. Protect interior drains and valleys from accumulation of debris and fallout, to prevent clogging. If accumulation becomes excessive, remove by hand shoveling.
5. Flush drainage system after firehosing.
6. Clean up "hot spots"
7. Backfill trenches and sumps on the ground.

Rate of Operation - The firehosing team should advance at approximately 250 square feet per minute, not including set-up or moving time, or rest periods. This rate will vary with the number of obstructions, the type of surface, the slope, and the amount of fallout.

LOBBING ON SLOPED ROOFS (Figure 6-E)

Special Comments - Lobbing has two distinct advantages over other methods of roof decontamination. First, it permits the team to operate on the ground and avoid the hazards created by structurally weak roofs and sloping, slippery surfaces. Second, the set-up, moving, and take-down time are greatly reduced. Although the rate of cleaning is somewhat slower than that of firehosing, the total time, including preparation and dismantling of equipment, will be little longer.

In general, lobbing should be used only on roofs with slopes greater than 3-on-12. Gutters and down pipes may tend to clog, particularly where fallout is heavy. Since the team will be on the ground, the first warning will be overflowing gutters. It is recommended, therefore, that gutters be removed prior to beginning the lobbing operation.

The firehose stream should be aimed above the roof, falling back like rain, and washing down the slope. The usual surface construction will be shingles, slate, tile, roll-roofing, or sheet metal. It is important to avoid aiming up the slope and lifting the shingles, driving fallout under them. The washing action should start at the high point or ridge line and progress down toward the edges.

The team should stand a safe distance from the building to avoid splash from the contaminant being washed from the roof. If this is not possible, use of a protective barrier or shield is advised. A trench should be dug under the roof edge, to collect the contaminant and to protect the team members from drainage.

Flush any splashed contaminant from the building side after finishing the roof. Avoid driving fallout particles under shingles or clapboards.

Procedure

1. Set up pump and hose lines. Adjust pressure to carry water above roof. Remove gutters and down pipes.

LOBBING ON SLOPED ROOFS (continued)

3. Trench ground under roof edges and dig sump.
4. With two hose lines and nozzles, begin at opposite ends of the roof or on separate, adjacent roofs.
5. Direct the water stream so that it falls onto the roof at the high point or ridge line and the water runs down and off the roof edge. When run-off appears clear, move the stream along the ridge.
6. Clean "hot spots" by additional hosing.
7. Flush building side.
8. Backfill the trench and sump.

Rate of Operation - The lobbing operation should clean the roof at approximately 200 square feet per minute. This rate does not include set-up or moving time, or rest periods for personnel. The rate will vary with the roof slope, composition, and amount of fallout.

FIREHOSING - PAVED AREAS (Figure 6-F)

Special Comments - Firehosing of pavement will usually be confined to small areas, those which are narrow and irregularly shaped, and those which contain numerous obstructions. Motorized flushing will be used for large, unobstructed areas.

If firehosing must be used for large or long areas, the operation will be greatly helped by dragging the heavy 2-1/2 inch main hose with the jeep, and relieving the hose and nozzle men of all but the shorter lengths of 1-1/2 inch branch hoses.

If the accumulation of debris and fallout particles becomes large, it should be removed by hand shovel and wheelbarrow. On very dirty paved areas, one shovel and wheelbarrow man will be needed to keep up with one nozzle man.

Procedure

1. Check drains prior to decontamination to make sure they are not clogged. Dig trenches and sumps at edges of pavement if drainage is inadequate.
2. Set up pump and lay out hose lines. Adjust pressure to 75 psi.
3. Begin firehosing at the high point of the slope and proceed downward, working toward the drains or edges.
4. Nozzle men advance side-by-side, pushing the contaminant ahead of them. Avoid washing excess amounts of dirt and debris into drains. Remove by hand shoveling.
5. On large areas, pull the heavy 2-1/2 inch hose by jeep.
6. Clean up "hot spots" by additional hosing and/or shoveling.
7. Flush drains after decontaminating area.

FIREHOSING - PAVED AREAS (continued)

8. Backfill trenches and sumps.

Rate of Operation - The firehosing team should advance at approximately 185 square feet per minute, not including set-up, moving, or resting time. This rate will vary, depending on the type and condition of the surface, the amount of fallout and debris, and the distance between drains.

FIREHOSING AND HAND SHOVEL - NATURAL AREAS

Special Comments - Where exposed rock formations are encountered, with only small amounts of earth cover, firehosing assisted by hand shoveling will be effective. The soil deposits are removed first, by shovel and wheelbarrow, followed by washing with the firehose.

As the natural rock surface is usually rough, containing fissures and cracks, this application will be slow compared with other firehosing operation. However, the only other feasible method, covering with clean earth, is both less effective and slower still, especially in locations where motorized equipment cannot be used.

Due to the roughness of the rock, the hose should be directed so that the water stream strikes the surface eight to ten feet away. Care should be exercised to avoid splashing other team members and recontaminating already cleaned areas.

Procedure

1. Select and prepare dump site.
2. Remove all large deposits of soil. Haul to dump site.
3. Prepare for drainage of run-off water, digging trenches and sumps at low side of rock formation, if necessary.
4. Set up pump and hose lines. Adjust pressure to 75 psi.
5. Begin firehosing operation at high point and work downward to low point.
6. Clean up "hot spots" by additional hosing.
7. Pick up and haul away contaminated soil at edge of rock formation where water run-off has carried fallout particles, or backfill if trenches and sumps have been used.

Rate of Operation - The rate is totally dependent upon the peculiarities of the area and the amount of fallout. The most important factors are the amount and distribution of soil cover and the roughness of the rock surface.

FIREHOSING - COLD WEATHER

Special Comments - The firehosing team will seldom be required to clean large, smooth areas, as the method is slow compared with mechanized methods.

The use of firehosing in winter depends upon the temperature. In very cold weather the water will freeze, trapping fallout in a sheet of ice.

FIREHOSING - COLD WEATHER (continued)

An application of salt to icy areas containing entrapped fallout particles will melt the surface and assist in washing away the contaminant.

Water should not be allowed to stand in the pump or hoses for more than short periods of time, to prevent freezing of the lines. They should be drained after completion of each operation, unless a new operation is to be started immediately.

Roof surfaces can be decontaminated in winter by firehosing, especially if the building heating system can be utilized to raise the roof temperature. Lobbing is recommended for steeply sloped roofs. On low-sloped or flat roofs, quick run-off must be achieved before the water freezes, unless internal heating is possible.

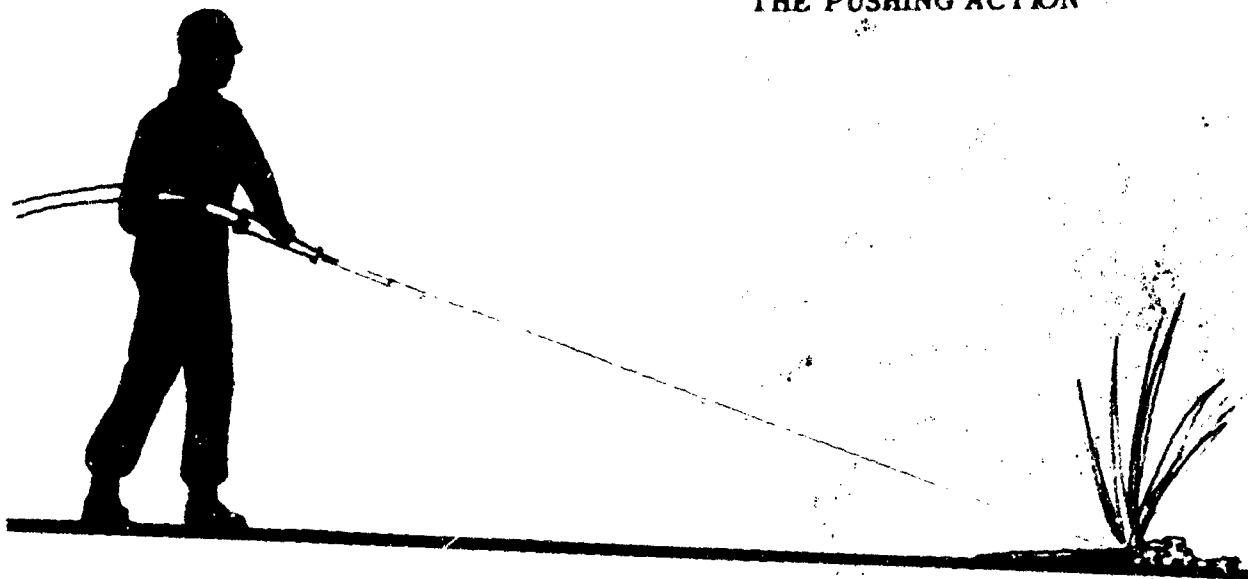
Hard-frozen ground cannot be trenched and will require decontamination from the run-off water and its load of particles.

Procedure

1. Check and clean drains prior to decontamination. Remove roof gutters.
2. Heat roof surfaces by raising internal building temperature. Remove roof insulation to hasten heating.
3. Spread salt, if necessary, to melt ice layer.
4. Set up pump and hose lines.
5. Begin operation at high point and proceed toward drains or edges.
6. Nozzle men advance side-by-side, pushing snow and contaminant ahead.
7. Sand will assist footing on slippery roofs.
8. Protect sewers and drains from accumulation by picking up excess and hauling away. Water flow must be maintained to prevent freezing.
9. Clean up "hot spots" by additional hosing or by shoveling. Use salt to melt refrozen areas.
10. Flush drainage system after firehosing.
11. Drain hoses and pump after completion of decontamination operation.

Rate of Operation - The team should advance at approximately 300 square feet per minute on bare, frozen ground, on pavement, and on flat and low sloped roofs. On hard packed snow and on salted icy surfaces, the rate will be approximately 200 square feet per minute. Relatively slight differences in the condition of the surface will cause large variations in these rates. However, it is important to remember that in cold weather firehosing, speed is required to prevent freezing and entrapping of the contaminant in ice.

AIMING NOZZLE AT LOW ANGLE
TOWARD SURFACE INCREASES
THE PUSHING ACTION



AIMING NOZZLE AT HIGH ANGLE
TOWARD SURFACE LOOSENS
ENTRAPPED PARTICLES

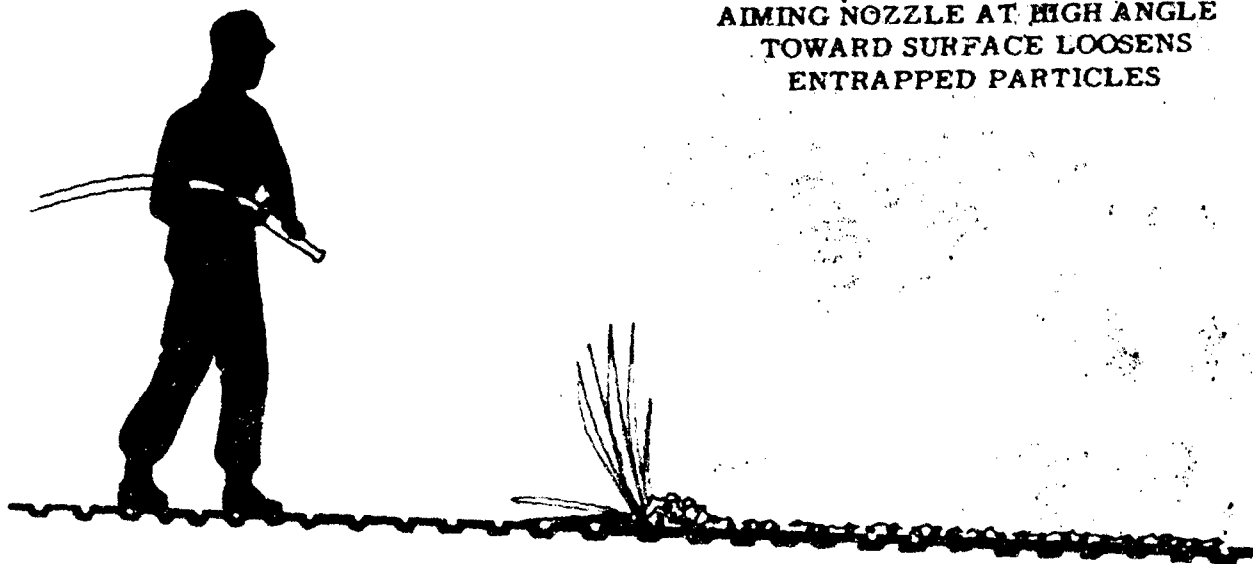
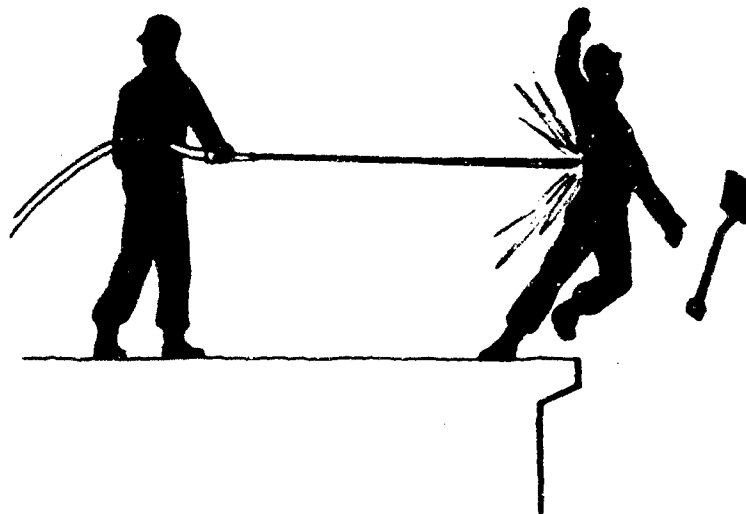


FIGURE 6-A FIREHOSING



USE CAUTION
IN DIRECTING HIGH VELOCITY
HOSE STREAM

DO NOT DIRECT STREAM
AGAINST LAP OF SHINGLE



BEWARE OF LOOSE,
BRITTLE, OR SLIPPERY
SHINGLES

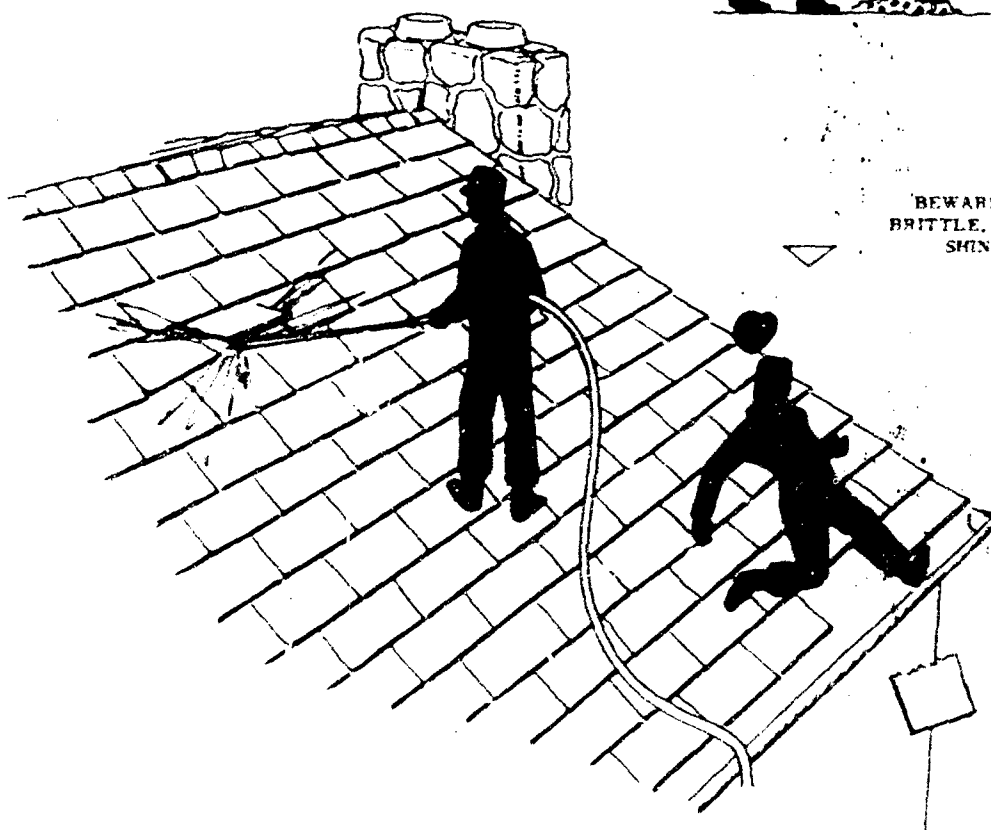


FIGURE 6-8 FIRE HOSE PRECAUTIONS

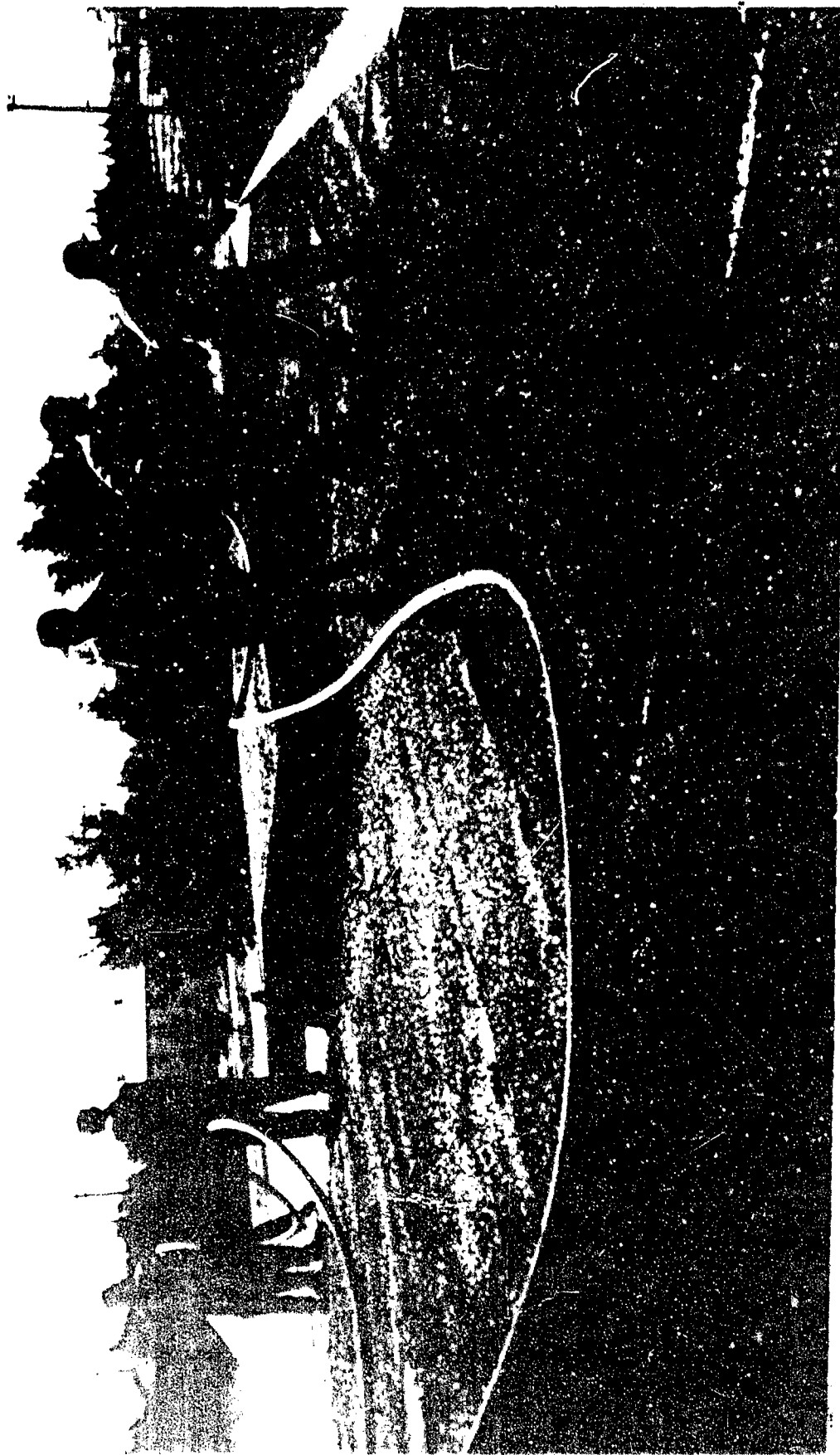
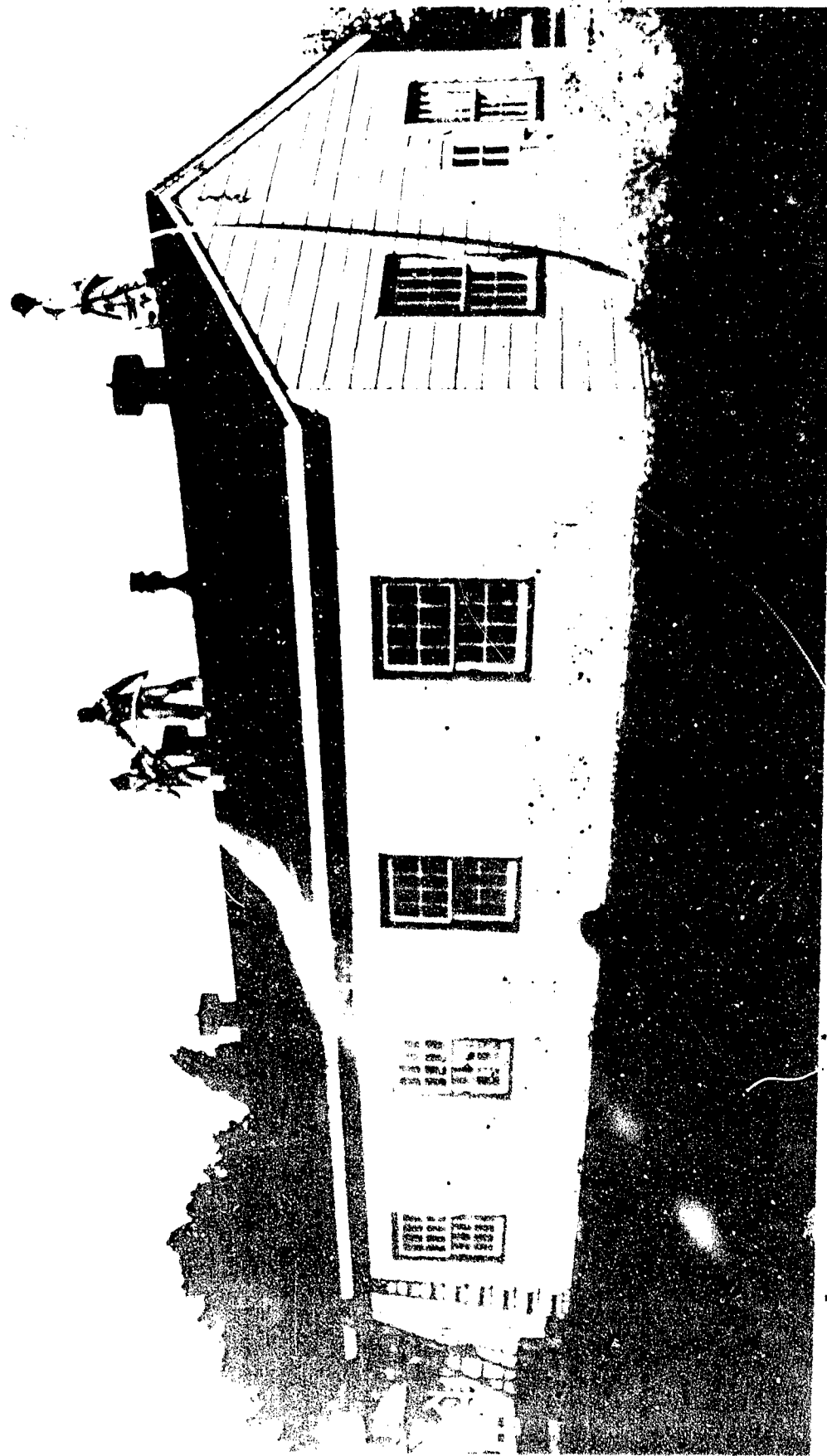
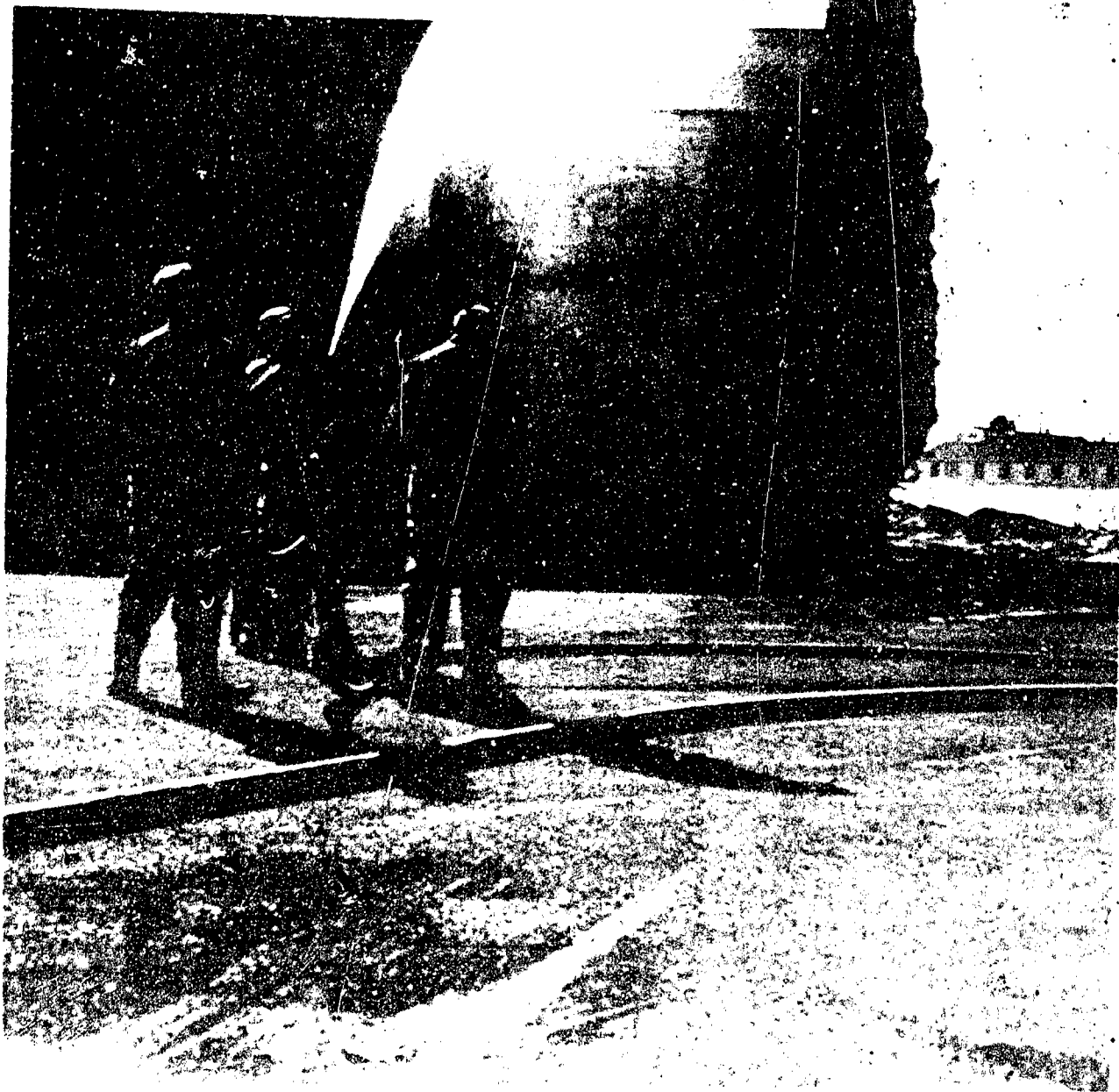


FIGURE 3-3-1. FIREHOSING TAR AND GRAVEL ROOFS.



REF 6-D FIREHOSING ROOF SURFACES OTHER THAN TAR & GRAVEL



THE FIRST OF THE NATION'S FARM - LOBBING

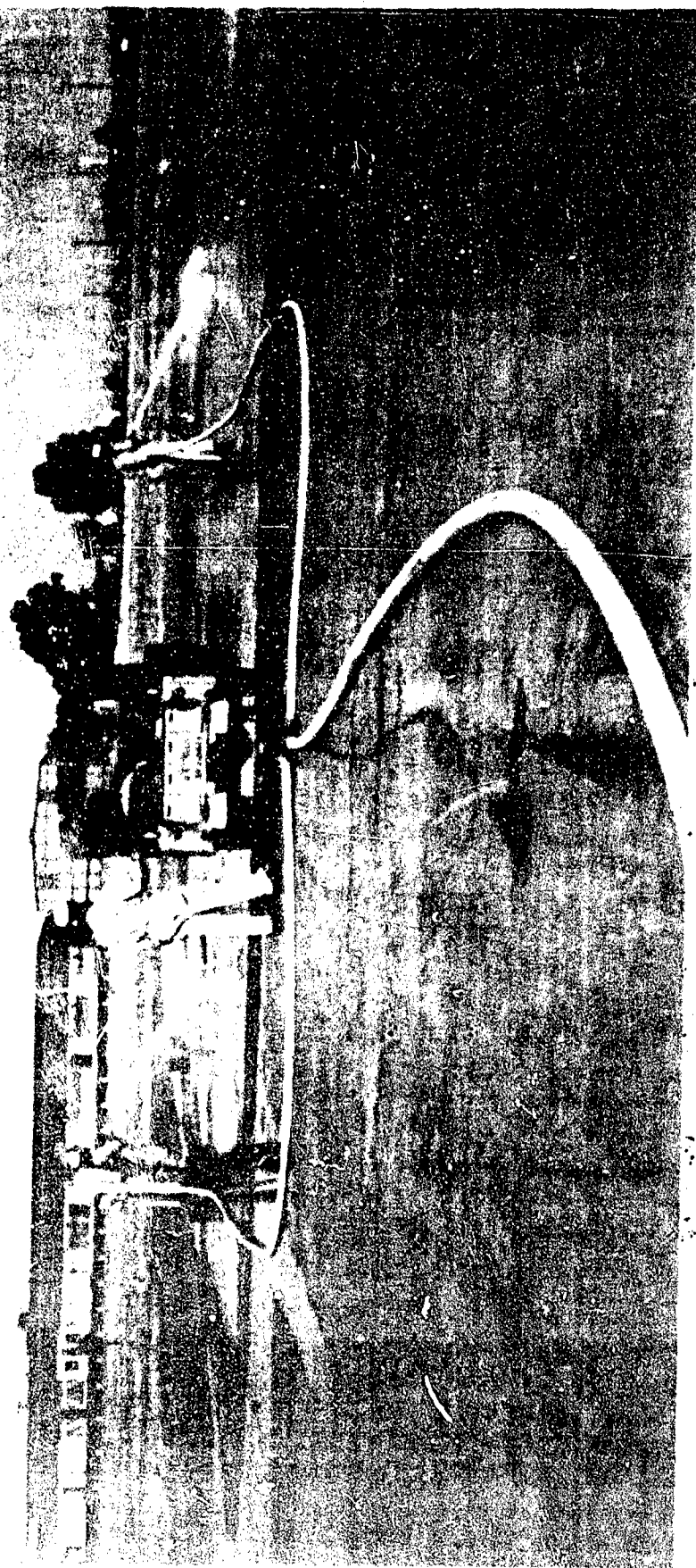


FIGURE 6-F. FIREHOSING PAVEMENTS

HANPOWER

A street flusher is operated by one man. "Hot spot" removal, however, requires the additional service of a firehosing team or of a sweeper-shoveler and a truck or wheelbarrow operator.

EQUIPMENT

In addition to conventional street flushers developed for peacetime street cleaning, an improvised street flusher, utilizing a tank truck, a high capacity pump, and a line of nozzles in a pipe header, has been tested carefully for pavement decontamination. This unit performed as satisfactorily and efficiently as a conventional street flusher and, in fact, overcame some of the drawbacks of conventional flushers.

CONVENTIONAL STREET FLUSHER (Figures 6-G and 6-H)

One motorized street flusher of approximately 3000 gallons water capacity equipped with a 200 to 500 gpm pump and two forward and two side nozzles.

IMPROVISED STREET FLUSHER (Figures 6-I and 6-J)

An improvised street flusher can be mounted on any available tank truck or tractor capable of pulling a tank trailer. Such systems offer a wide range of possibilities, since there is very little size restriction in construction of the nozzle header. Small, highly maneuverable, jeep drawn systems may be designed for sidewalks and ramps. Extra large capacity systems, consisting of series of tank trailers drawn by tractors, can be used.

The main objective of improvised flushers, however, is to supplement the small number of conventional flushers presently available.

The equipment needed to construct the improvised flusher illustrated, in addition to the truck or tractor and trailer, is:

1. One 500 gpm pump suitable for gasoline engine drive or for power take-off from the tractor
2. One 8-1/2 foot length of 2 inch standard galvanized steel pipe drilled and tapped on six inch centers for 14 nozzles. The pipe should be plugged on the ends and fitted with attachments for two inlet hoses and two adjustment and mounting brackets. (See Figure 6-K)
3. Fourteen flat, jet-type nozzles, Spraying Systems Company, Belwood, Illinois, Model No. U-40150, or equivalent
4. Two suitable lengths of 2-1/2 inch firehose with fittings to supply the nozzle header pipe
5. Suitable lengths of 2-1/2 inch pipe and fittings to connect the tank, pump, and firehoses.

PRINCIPLE OF OPERATION

Motorized street flushers utilize the force of high velocity water jets to dislodge and wash away dirt and fallout particles from paved surfaces. A large volume of water is carried in the tank, and multiple spray nozzles permit coverage of the full vehicle width while the flusher moves forward.

ADVANTAGES AND LIMITATIONS

Motorized street flushing is the most efficient of the paved area decontamination methods. Like other wet methods, however, it is dependent upon slope, or crown, and adequate drainage for the removal of run-off water. Also, in common with other motorized methods, its efficiency is impaired by the presence of numerous obstructions and by irregularly shaped areas.

Street flushers wash fallout particles and debris to one side as they move along. In multiple pass operations, the accumulation of earlier passes must be moved, along with the newly loosened material. Street flushing, therefore, is limited to paved roadways of about 70 feet width, where the edges can be reached in two or three passes from the centerline.

This limitation can be applied also to the distance between drainage points in large paved areas. Flushers can move fallout particles inward toward drains located in depressions, in two or three spiral passes, and effectively decontaminate large areas.

Conventional street flushers have several drawbacks for decontamination use. The water streams emerge in wide-angle spray patterns which prevent control over the directions the fallout particles are pushed. The stream patterns are nonuniform in the direction of motion of the vehicle, and cause uneven, streaked cleaning. When adjustments are made which satisfactorily overcome these problems, one set of vehicle wheels is outside the water stream pattern and must track through contaminated material.

GENERAL INSTRUCTIONS

The direction of motion of street flushers should be such that run-off water does not drain back over the surface just cleaned. The crowning of roads provides side drainage, so flushing can proceed both up and down grade. On wider areas, motion should be across grade, with the water washing toward the down-grade side.

Along roadways, in particular, the final line of contaminant accumulation will be the edge or gutter. It will be necessary to remove this by flushing into storm sewer drains or by shoveling and hauling away in wheelbarrows or trucks.

Procedure

1. Check drains for clogging. If drainage system is inadequate, dig trenches and sumps at edge of pavement.
2. On conventional street flusher, set nozzle orifices at 1/16 inch.
3. Set nozzle angle of attack with pavement at between 30° and 45°.

PROCEDURE (continued)

4. On conventional street flusher, set front nozzles to match so that water jets impinge on pavement in an uninterrupted straight line. This line should be canted at an angle of 30° to the line of travel.
5. On improvised street flusher, set nozzle header at 60° angle to the direction of travel, so that nozzles point 30° to the side.
6. Adjust pressure. On conventional street flusher, set to maximum. On improvised street flusher, set for 85 psi nozzle pressure.
7. Begin at centerline of road or top of slope on larger paved area.
8. On roads, move along, parallel to centerline, making return trip on opposite side of centerline, and shifting one spray pattern width (about five feet) toward the edge of each successive pass.
9. On wide areas, move across the slope, spraying toward the downhill side. If the area drains to an edge of the pavement, move back and forth, shifting one spray pattern width downgrade on each pass. If the area drains into a centrally located drain hole, move around the hole, spiralling in, one spray pattern width, on each circuit.
10. If the roadside is curbed, straddle the curb, washing the gutter in the downhill direction toward storm sewer drain openings, or use special side nozzles, if available on conventional street flusher.
11. Clean "hot spots" by reflushing, firehosing, or shoveling.
12. Flush drains after decontaminating pavement.
13. Backfill trenches and sumps.
14. If road or area is drained by unpaved ditches, these should be decontaminated by filling with clean earth or by a dry surface pick-up method.
(See Chapter 7)

Rate of Operation

The conventional street flusher, as well as the improvised street flusher shown in Figures 6-I and 6-J should advance at approximately 2-1/2 miles per hour. This rate will vary, depending mainly upon surface material and condition and amount of fallout.

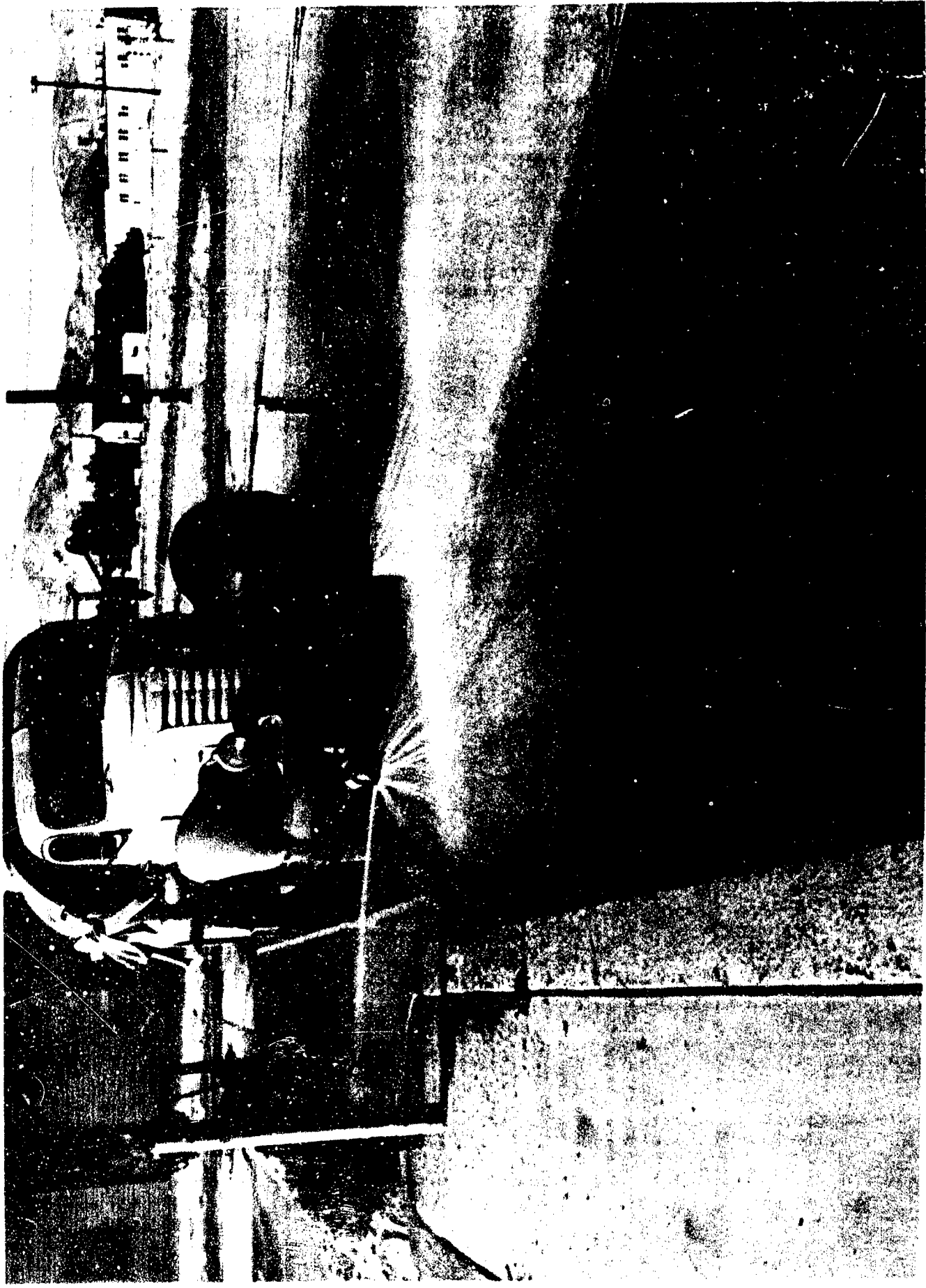


FIGURE 6-G CONVENTIONAL STREET FLUSHER .



FIGURE 6-H CONVENTIONAL STREET FLUSHER SHOWING SIDE NOZZLES

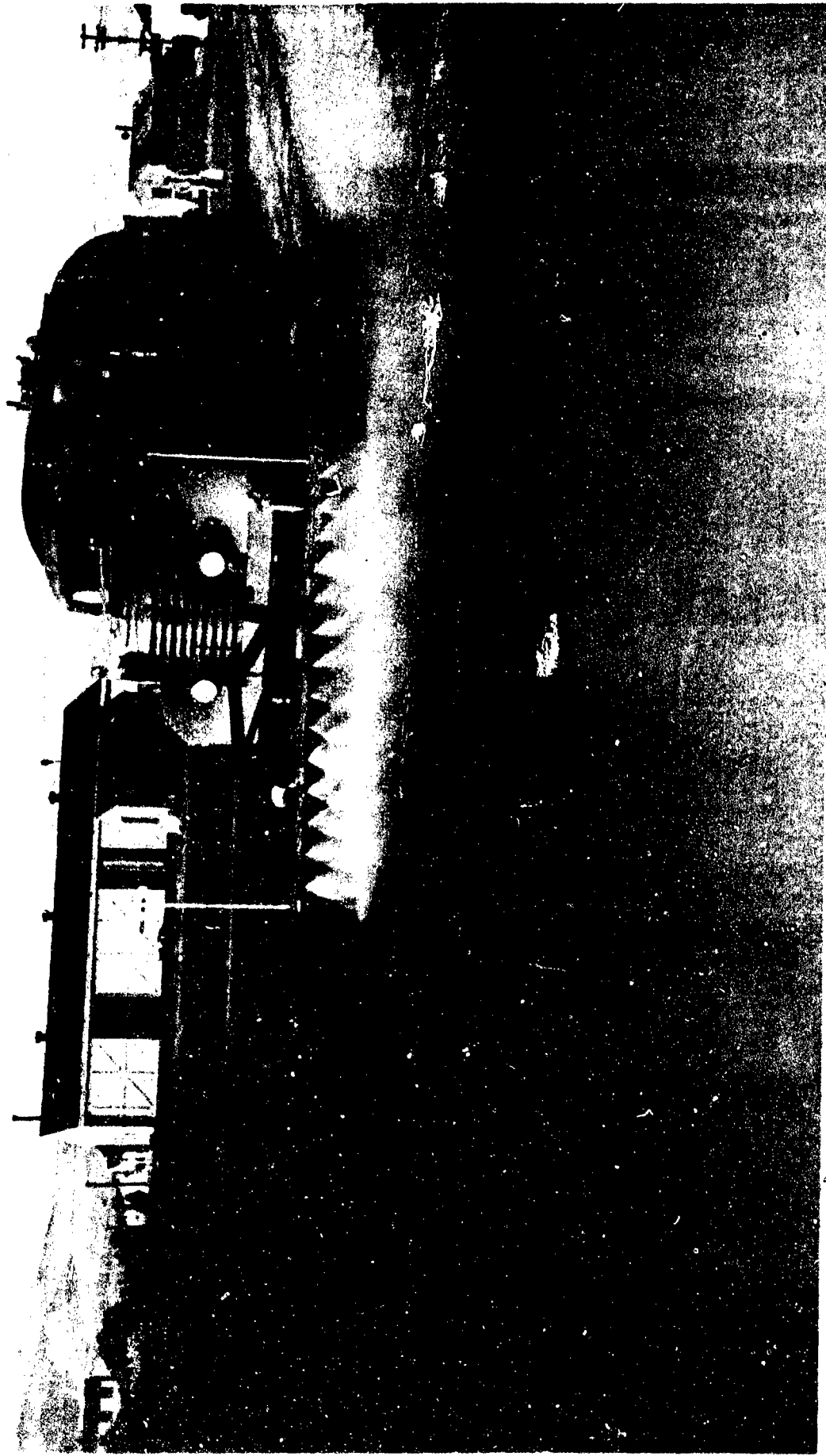


FIGURE 6-1 IMPROVED STREET FLUSHER

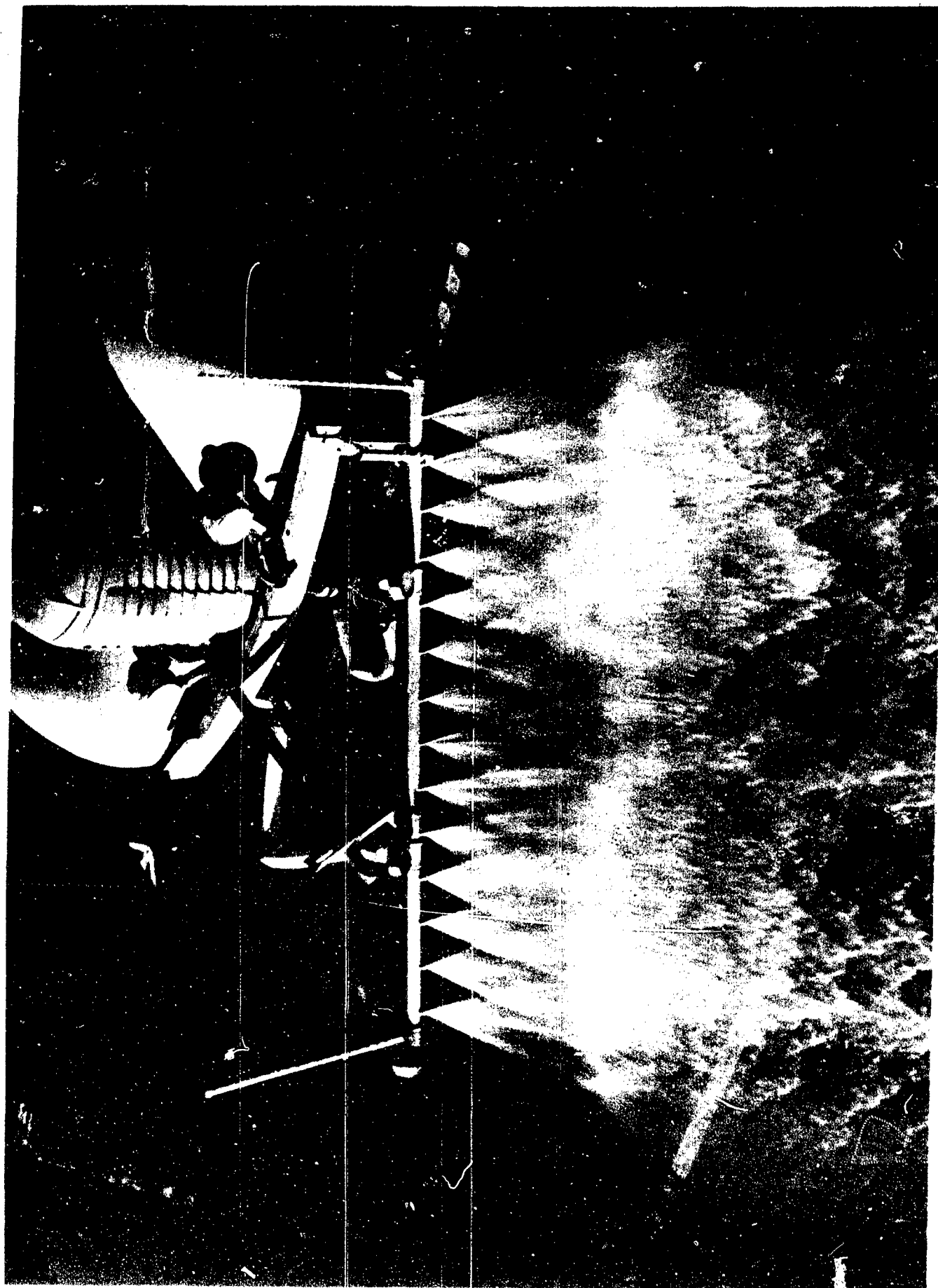


FIGURE 6-J IMPROVISED STREET FLUSHER SHOWING 60° ANGLE BETWEEN
NOZZLE BAR AND LINE OF TRAVEL

CHAPTER 7

DRY DECONTAMINATION METHODS

ABSTRACT

Dry decontamination operations include both surface clearing, surface removal, and surface shielding or covering methods. This chapter consists of separate sections for these methods, intended for use by the Decontamination Team members independently of the remainder of the Manual. Manpower and equipment requirements, operating instructions, and the various decontamination applications are also listed.

The sections included cover: manual sweeping, mechanical sweepers, vacuum sweeper, hand knocking, roller sweeper, roller brush, collector, piler and snow pile.

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7.1 Scope

The dry decontamination methods, which use mechanical force rather than washing action to remove fallout particles, are grouped in this chapter. Manpower and equipment requirements as well as operating procedures are shown.

The cleaning methods, for paved and hard frozen surfaces, are included in one section. The surface removal and cover-over methods, mainly for unpaved areas, are included in a second section. Snowplowing is also included in this section.

Each method, based on type of equipment, is printed on separate pages. These may be used independently of the Manual as operating instruction pamphlets, by removing them, or by obtaining additional printed pages.

7.2 Principles of Dry Decontamination

Paved and hard frozen surfaces may be cleaned by sweeping, either manually or mechanically. While this principle is somewhat less efficient than flushing with water, it can be applied when water under pressure is not available and where drainage cannot be achieved. It must be used when temperatures are so low that water will freeze before it can drain off.

Natural areas are decontaminated by removing the surface layer of material, including fallout particles. This can be done manually, by shovel and wheelbarrow, or mechanically, by scraper, grader, bulldozer, etc.

Contaminated, unpaved areas in Buffer Zones may be shielded sufficiently by plowing the surfaces under. Both paved and unpaved surfaces in Buffer Zones may be covered with uncontaminated earth, by shovel, or by machine.

7.3 Dry Methods Included in This Manual

Chapter 7 includes a section on surface cleaning and a section on surface removal and surface covering.

The surface cleaning section contains instructions for the following methods and equipment:

1. Manual Sweeping
2. Mechanical Sweeper
3. Vacuum Sweeper

The surface removal section contains instructions for the following methods and equipment:

1. Hand Shoveling
2. Motor Scraper
3. Motor Grader
4. Bulldozer
5. Plowing
6. Snow Plow.

7.4 Surface Cleaning Methods

The surface cleaning methods utilize brooms or brushes to loosen and sweep the fallout particles. These methods are limited to hard surfaces, such as pavement and frozen ground.

7.5 Surface Removal and Covering Methods

The surface removal and covering methods utilize earth moving equipment. The top layer is removed, turned under, or covered over to effect surface decontamination. These methods, therefore, are limited to areas which are unpaved and not frozen deeply.

It is desirable to remove as little of the surface as possible to minimize the effort required. Tests have established that a depth slightly greater than the surface irregularities will effectively remove fallout. Usually two to four inches of soil removal is sufficient. Fissures and cracks are sometimes deeper, and fallout particles in them remain after the equipment has passed. These "hot spots" can be removed manually in a subsequent operation.

Turning-under, to the depth obtainable by plowing or spading, about six to eight inches, is effective in Buffer Zone decontamination. Covering-over, depending upon availability of clean fill, can be deeper and, therefore, still more effective.

MANUAL SWEEPING

Page 1 of 1

May 1964

MANPOWER

A two man team is required for manual sweeping, one man to sweep and one to handle the shovel and wheelbarrow.

EQUIPMENT

Long handled push brushes are desirable, used with shovels and wheelbarrows to remove the contaminant. While hand sweeping action is not usually violent enough to stir up dust, on windy days it may be advisable to sprinkle the area with water for dust suppression.

Carpet sweepers and vacuum cleaners (the latter requiring long extension cords) pick up the fallout particles and do not need help from shovelers. Water dust suppression should not be applied. Hoppers and collection bags are emptied into wheelbarrows or trucks for disposal of the contaminant.

PRINCIPLE OF OPERATION

This method uses hand brooms, carpet sweepers, vacuum cleaners, etc., for sweeping fallout particles from paved and hard frozen surfaces.

LIMITATIONS

Manual sweeping is so inefficient that it should be confined to such minor duties as "hot spot" clean-up and cleaning around building entrances, steps, etc. It has the advantages that no special skill is required and equipment is available in every home.

RATE OF OPERATION

While the operating rate for this method is very slow, the method will be used only on "hot spot" and very small area clean-up assignments. Accordingly, moving and disposal time for contaminant loaded into the wheelbarrow will play a major role in the overall time, and actual rate of operation will not be significant.

MANPOWER

Mechanized sweeping is a one man operation. However, if the area has many "hot spots" left after decontaminating, due to obstructions or rough and broken pavement, it may be desirable to clean these by manual sweeping or other method. The mechanical sweeper, then, can go on to another large area.

EQUIPMENT

This method of decontamination requires a motorized street sweeper, Wayne Model 450, or equivalent, with a 58 inch wide, natural bristle main broom, two 45 inch diameter gutter brooms, and a three cubic yard hopper.

PRINCIPLE OF OPERATION

The mechanical sweeper is a thoroughly efficient means of decontaminating large paved or frozen areas. The fallout particles are mechanically loosened by a revolving main broom and deposited on a conveyor which carries them to a hopper. Gutter brooms are available for edge of the road and curb decontamination.

Automatic water sprinkling for dust suppression, by means of a spray system, can be applied as required. However, water interferes with dust pick-up and should be used sparingly. Water should not be used, of course, in below-freezing weather.

GENERAL INSTRUCTIONS

The dump site should be selected in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time. The distance may be shortened by dumping the contents of the hopper behind a natural or prepared barrier or into an excavated ditch, which will shield the cleared area from its radiation. The dump site should be backfilled after decontamination is completed.

ADVANTAGES AND LIMITATIONS

Since the fallout particles are collected in the machine's hopper and not pushed along toward a drain or collection point, this method can be used without regard to slope, crown, or pavement width.

The broom bristles are not stiff enough to cut into ice or hard packed snow. This method is suitable for natural area cold weather use only where fallout particles lie on top of bare frozen surfaces or where shallow, dry snow is encountered.

The fallout particles collected in the hopper constitute a radiation hazard to the operator. As discussed in Chapter 1, Section 1.10, shielding of the operator's seat should be provided.

PROCEDURE

1. Select and prepare dump site.
2. Begin operation at edge of pavement or frozen area and work back and forth in parallel, overlapping paths.
3. Sprinkle water if surface is very dry and dusty and temperature is above freezing. Only use water spray if absolutely necessary.

PROCEDURE (continued)

4. Clean up "hot spots" with mechanical sweeper or manual sweeping team.
5. Backfill dump site.

RATE OF OPERATION

The sweeper should advance at between 1-1/2 and 2-1/2 miles per hour, depending upon the amount of dirt, or other loose material, and fallout on the surface, and upon the surface smoothness. This rate does not include time required for travel to and from the dump site, or for equipment maintenance and operator rest periods.



FIGURE 7-A MECHANICAL SWEEPER

RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES	DRY DECONTAMINATION METHODS	
VACUUM SWEEPER	Page 1 of 2	May 1964
<p><u>MANPOWER</u></p> <p>Motorized vacuum sweeping is a one man operation. However, if the area has many "hot spots" left after decontaminating, due to obstructions or rough and broken pavement, it may be desirable to clean these by manual sweeping or other method. The vacuum sweeper, then, can go on to another large area.</p>		
<p><u>EQUIPMENT</u></p> <p>Two types of vacuum sweeper are mentioned here. One, the Tennant 100 (Figure 7-B), has been used during decontamination experiments. The other, the Tennant 88 (Figure 7-C), is a newly developed model, designed specifically for industrial and small area use. This model promises good results but needs field testing before full acceptance.</p> <p>The Tennant Model 100 has a 48 inch wide, African bass filled, main pick-up broom and two 32 inch diameter, nylon bristle gutter brooms. Hopper capacity is 1-3/4 cubic yards, and the hopper dumps automatically in six seconds. Filter area is 540 square feet. This unit was designed specifically for street and open area use.</p> <p>The untested Tennant Model 88 utilizes a 42 inch wide main pick-up broom and one 21 inch diameter gutter broom. Hopper capacity is 800 pounds. The hopper dumps automatically in ten seconds. Filter area is 125 square feet.</p>		
<p><u>PRINCIPLE OF OPERATION</u></p> <p>The vacuum sweeper is a thoroughly efficient means of decontaminating large paved or frozen areas. The fallout particles are mechanically loosened by a revolving broom and sucked into a hopper. The air passes through a series of filters which trap airborne particles.</p>		
<p><u>ADVANTAGES AND LIMITATIONS</u></p> <p>Since the fallout particles are collected in the machine's hopper and not pushed along toward a drain or collection point, this method can be used without regard to slope, crown, or pavement width.</p> <p>Because of the filter system, this method cannot be used in wet weather, nor can ter dust suppression be applied.</p> <p>The fallout particles collected in the hopper constitute a radiation hazard to the operator. As discussed in Chapter 1, Section 1.10, shielding of the operator's seat should be provided.</p> <p>The broom bristles are not stiff enough to cut into ice or hard packed snow. This method is suitable for natural area cold weather use, therefore, only where fallout particles lie on top of bare frozen surfaces or where very shallow, dry snow is encountered.</p>		
<p><u>GENERAL INSTRUCTIONS</u></p> <p>The dump site should be selected in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time back and forth. The distance may be</p>		

VACUUM SWEEPER

Page 2 of 2

May 1964

GENERAL INSTRUCTIONS (continued)

shortened by dumping the contents of the hopper behind a natural or prepared barrier or into an excavated ditch, to shield the cleared area from its radiation. The dump site should be backfilled after decontamination is completed.

PROCEDURE

1. Select and prepare dump site.
2. Begin operation at edge of pavement or frozen area and work back and forth in parallel, overlapping paths.
3. Clean up "hot spots" with vacuum sweeper or manual sweeping team.
4. Backfill dump site.

RATE OF OPERATION

The vacuum sweeper should advance at between 1-1/2 and 2-1/2 miles per hour, depending upon the amount of dirt, or other loose material, and fallout on the surface, and upon the surface smoothness. This rate does not include time required for travel to and from the dump site, or for equipment maintenance and operator rest periods.

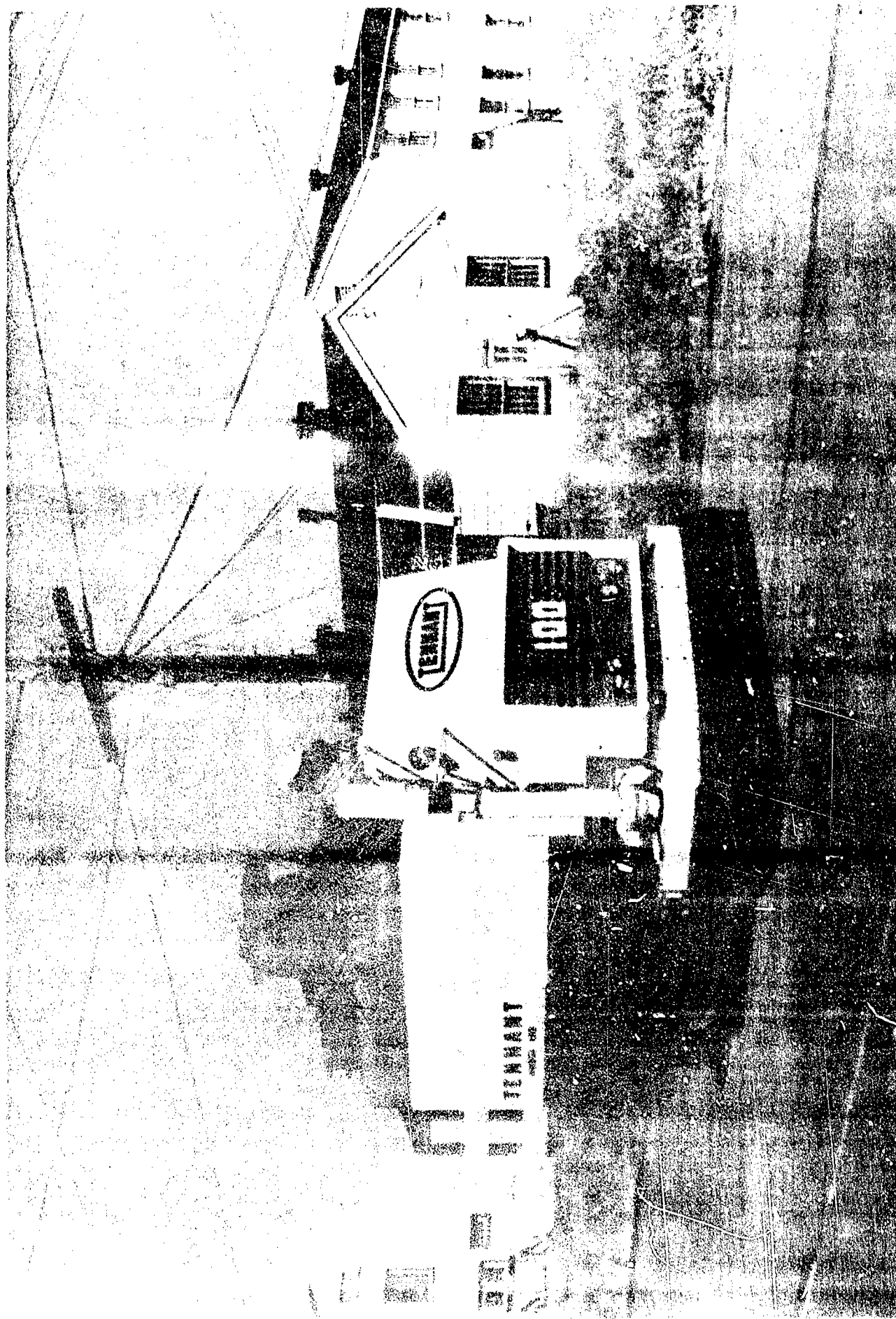


FIGURE 7-B VACUUM SWEEPER - TENNANT MODEL 100

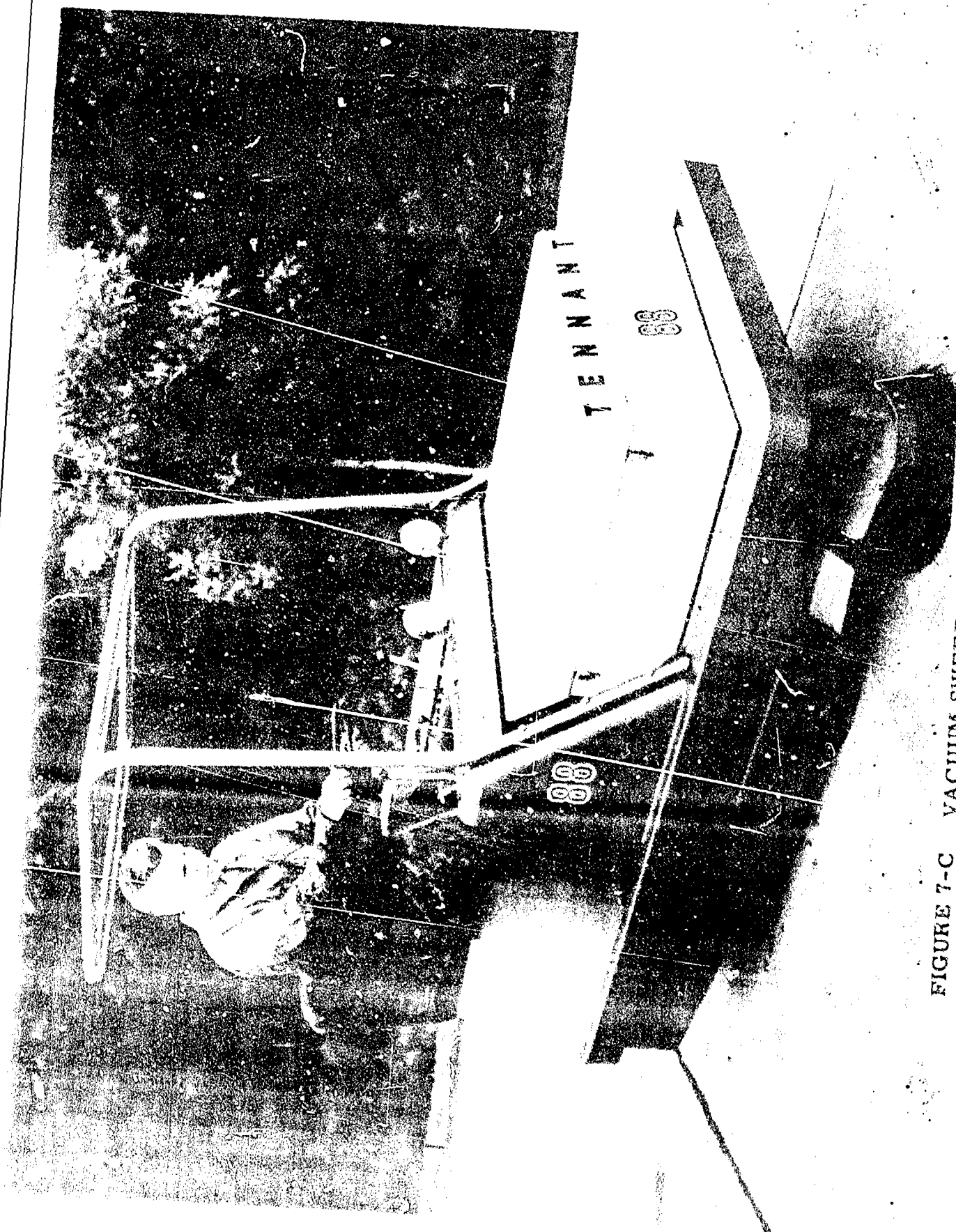


FIGURE 7-C VACUUM SWEEP - TENNANT MODEL 88

RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES		DRY DECONTAMINATION METHODS	
HAND SHOVELING		Page 1 of 1	May 1964
<u>MANPOWER</u> A one man team with shovel and wheelbarrow can operate most effectively on the majority of assignments. Multiple teams may be required to keep up with motorized equipment on "hot spot" clean-up jobs.			
<u>EQUIPMENT</u> One long handled shovel One wheelbarrow			
<u>APPLICATION</u> Hand shoveling, like other manual methods, is slow and inefficient. Its principal function is for cleaning up "hot spots" and around buildings, trenching and backfilling, etc. No special skill is required. Equipment is simple and readily available.			
<u>RATE OF OPERATION</u> Wheelbarrow hauling time, for taking contaminated dirt or snow to the dump site, will occupy a large proportion of the total time. Rest time, for this relatively strenuous work, will also be important. Actual digging rate will vary from man to man and job to job.			

MANPOWER

The motor scraper requires one man to operate. However, if the area has many "hot spots" left after decontamination, due to deeply fissured earth, large rocks near the surface, obstructions, etc., these will require clean-up by other methods. One or more shovel and wheelbarrow teams or a bulldozer may be needed. Areas which require dust suppression by water spray will need a firehose team or other spraying means. (See Figure 7-D.) Dump site preparation may require shovel teams or a bulldozer.

EQUIPMENT (Figure 7-E)

This method of decontamination (scrapping the surface) requires a motor scraper, preferably with a 12 cubic yard or greater hopper capacity. Scrapers with smaller hoppers, such as eight cubic yards, may be used satisfactorily, but a larger capacity increases efficiency by reducing the frequency of trips to the dump site.

PRINCIPLE OF OPERATION

Motor scraping is one of the most rapid and effective methods of decontaminating large natural areas and areas covered by loose undisturbed snow. A surface layer including the fallout particles, is cut and loaded into a hopper as the vehicle moves along. Besides being capable of operating independently to scrape up and haul away the contaminated layer of soil, motor scrapers may be used effectively with such other mechanized equipment as motor graders, bulldozers, and snow plows. Graders and snow plows leave the contaminated material in windrows. Bulldozers push it into long mounds as they work across an area. The scraper may be used to pick-up the windrows and mounds and transport the contaminant to the dump site.

The motor scraper is especially useful for filling, or covering Buffer Zone areas with uncontaminated soil. Filling will be indicated for paved or deep frozen surfaces and for exposed rock formations, which cannot be decontaminated by other methods. Its application, of course, is dependent upon the availability of sufficient clean earth. Because it can procure, pick-up, haul, deposit, and spread the cover soil, the motor scraper is the most efficient machine for this method of decontamination.

GENERAL INSTRUCTIONS

A compromise must be made between the thin cut desired for decontamination and the machine capability. Scrapers are designed to allow the shear resistance of the cut layer of soil to fill the hopper as the cutting blade edge moves forward. When the soil is crumbly and loose and the cut is thin, the hopper does not receive all of the cut layer. Some contaminated material spills to the sides and must be removed by additional operation.

The loss of efficiency from side spillage can be minimized by following the operating pattern shown in Figure 7-F. The first pass is made in one direction across the area. Pass two is made in the opposite direction, and a five to six foot gap is left between the passes. The third pass picks up the material from this gap, and since the blade is wider than the unscrapped surface; spillage is essentially eliminated. Pass four is made, leaving a gap beside pass two, etc.

GENERAL INSTRUCTIONS (Continued)

Sprinkling with water prior to scraping is advisable under very dry conditions, to suppress dust. A light water spray will also improve cohesiveness of the soil and decrease the tendency toward spillage.

Snow removal by motor scraper is most applicable when the snow depth is between three and six inches. Deeper snow fills the hopper rapidly and requires frequent time consuming trips to the dump site.

The dump site should be selected in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time. The distance may be shortened by dumping the scraper hopper behind a natural or prepared barrier or into an excavated ditch, to shield the cleared area from the fallout radiation. The dump site should be backfilled after decontamination has been completed.

The fallout particles collected in the hopper constitute a radiation hazard to the operator. As discussed in Chapter 1, Section 1.10, shielding of the operator's seat should be provided.

For decontaminating Buffer Zone areas by covering with clean earth, six to eighteen inches of fill should be applied evenly over the surface. While this will not provide much shielding for persons standing in the Buffer Zone, it will give several feet of oblique shielding to the cleared areas near the Buffer Zone. (See Chapter 4, Section 4.2). The method is carried out in the same manner as conventional filling. At the site where the fill material will be obtained the surface layer should be stripped and moved to one side, exposing the clean soil underneath.

PROCEDURE

1. Select and prepare dump site.
2. Sprinkle dry, dusty area with water spray.
3. Begin operation along one side of area, returning in opposite direction, leaving a gap between passes equal to about $2/3$ of the cut width.
4. Minimum depth of cut should be two inches. Adjust for greater depth if soil conditions warrant.
5. Do not fill hopper to capacity. Haul away and dump before hopper heaps over, to avoid spilling.
6. Clean up "hot spots" with shovel and wheelbarrow, bulldozer, etc.
7. Backfill dump site.

RATE OF OPERATION

The motor scraper should operate at one half to three miles per hour while loading. Travel to and from the dump site should be at maximum practical speed, depending on ground conditions and tractor capability.



FIGURE 7-D DUST CAUSED BY LAND DECONTAMINATION EQUIPMENT

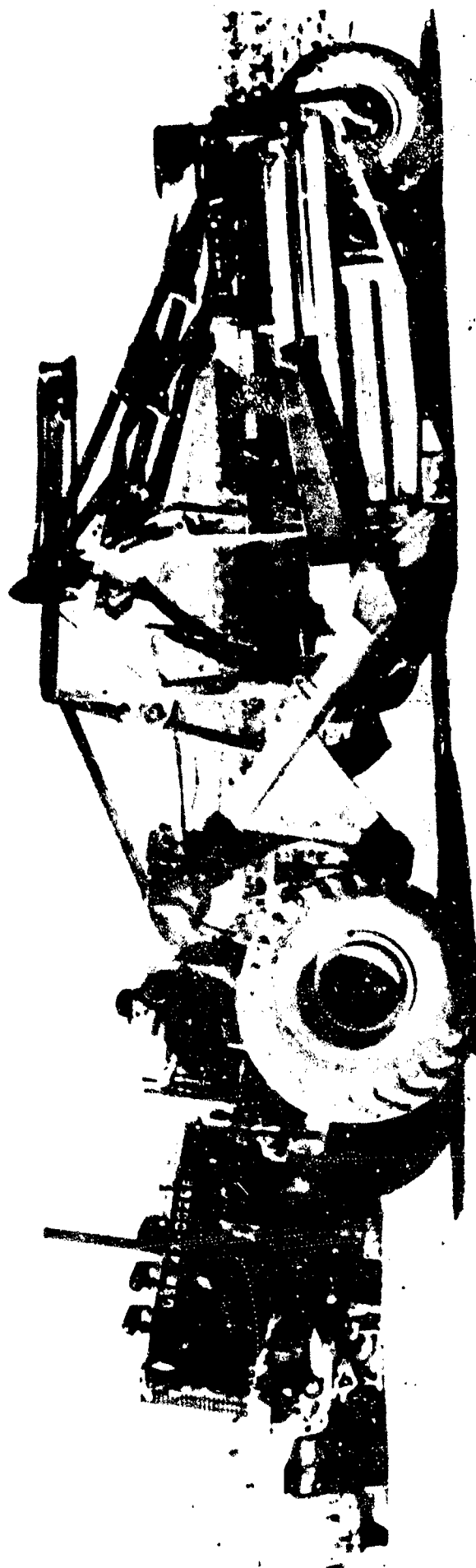
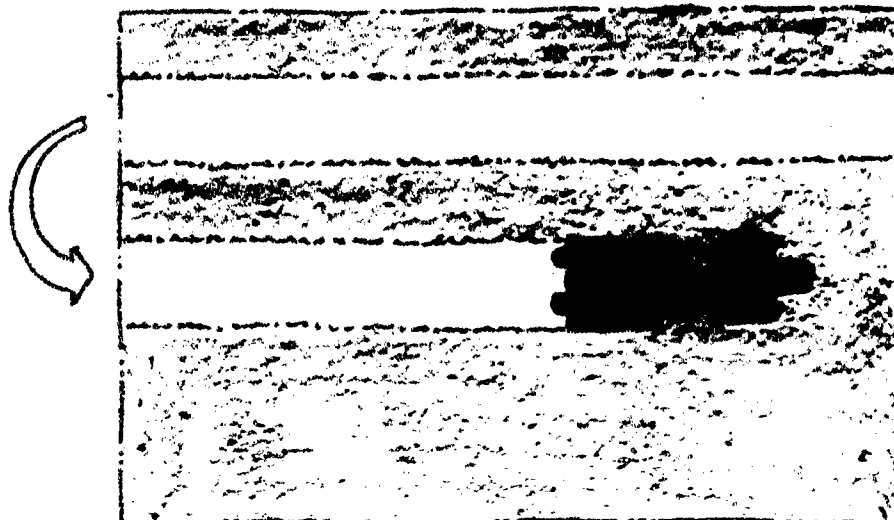


FIGURE 7-E MOTOR SCRAPER

1st PASS



2nd PASS



3rd PASS

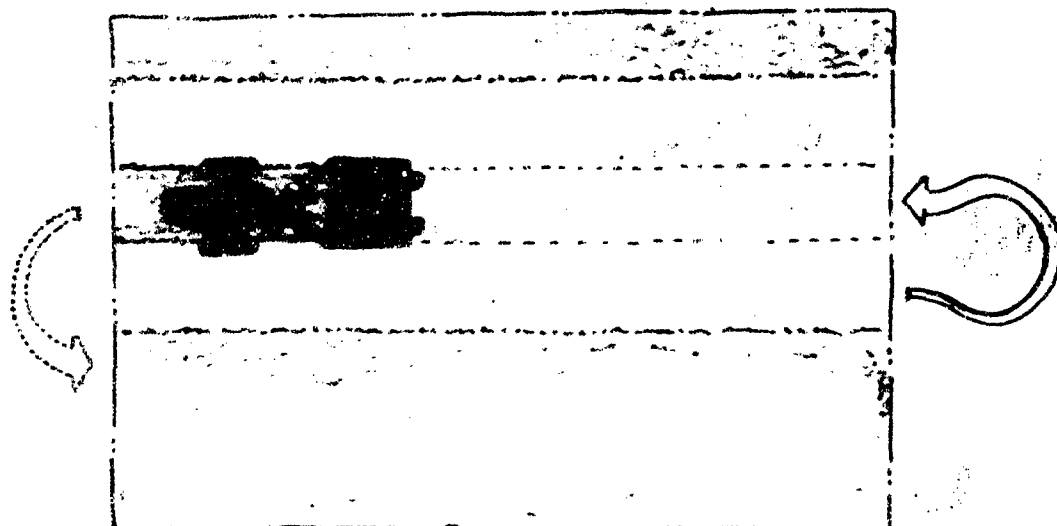


FIGURE 7-F PROCEDURE FOR USING MOTOR SCRAPERS

MANPOWER

Motor grader operation requires one man. However, pick-up and disposal of the contaminated windrow material will require additional workers. A motor scraper (previous section) has a one man team. A front end loader and truck require two men, one for each vehicle. "Hot spot" clean-up will require one or more shovel and wheelbarrow men.

EQUIPMENT (Figure 7-G)

The motor grader required for these methods should be equipped with a ten foot or longer moldboard, if possible. Graders with shorter blades are usable, but the area covered per pass, and therefore, the efficiency, are lowered.

Pick-up and hauling equipment is also required to remove the windrows to the dump site.

PRINCIPLE OF OPERATION

Motor graders provide a fast, effective means for decontaminating flat or gently sloped, natural and snow covered areas. They are designed to cut off thin surface layers and push the cut material into windrows. Because they do not pick-up and haul loose material, other means must be employed to move the contaminant to the dump sites.

Motor graders normally operate with the blade set at an angle to the direction of motion. As the cut material is pushed ahead, it drifts to the side with a rolling and sliding action. The mold board (blade) is curved to assist in the rolling and sliding action and to prevent spillage over the blade top.

The size of the windrow thus formed is dependent upon the depth of cut, angle and length of blade, and properties of the soil or snow. For each material-grader combination there is a maximum size of windrow that can be created.

By straightening blade angle, the grader can be used to push the windrows to the edge of the contaminated area, if the length of push is not so great as to cause spillage around and over the blade. However, the motor scraper (see previous section) provides one of the most efficient means of picking up and hauling the contaminant to the dump side, and it is equally efficient in picking up the windrows directly (Figure 7-H).

Another efficient means of picking up and hauling away the windrows is provided by a front end loader (Figure 7-I) and truck which follow behind the grader.

Motor graders can be used for covering Buffer Zone surfaces with uncontaminated fill. A covering of six to eighteen inches of fill should be applied evenly over the surface. While this will not provide much shielding for persons standing in the Buffer Zone, it will give several feet of oblique shielding to the cleared areas near the Buffer Zone. (See Chapter 4, Section 4.2).

The grader cannot procure and haul the fill material, but it is especially effective for spreading fill material over the surface, once trucks or other hauling vehicles have delivered it to the area. It can also be used effectively for stripping the contaminated top layer of soil at the site where the clean fill will be procured,

PRINCIPLE OF OPERATION (continued)

and for digging up the fill material itself into windrows, for loading into trucks.

GENERAL INSTRUCTIONS

In general, the procedure to be followed in decontaminating with the motor grader is that recommended for peacetime use. The blade should be set for the maximum recommended angle, to avoid spillage around the leading end; the pitch should be set, to minimize spillage over the top of the blade; and the depth should be set for two inches or more of cut; to avoid skipping over low spots and spillage under the blade. The depth of cut in snow, greater than two inches, will be dependent on the location of the fallout particles in the snow. (see Chapter 5, Section 5.5)

The grader should follow the pattern shown in Figure 7-J. Operation should be back and forth along the long dimension of the area. With the moldboard angled for a windrow on the right, decontamination should start along the right hand side of the area. The second pass should be parallel to the first, in the opposite direction, and slightly overlapping. The windrow will again be thrown to the right but from the opposite direction. The third pass should be made in the original direction, and the windrow thrown against that made on the second pass. The cleared spaces between windrows will thus be approximately two blade widths.

If the soil is dry and dusty, a water spray application for dust suppression may be desirable before decontamination. (See Figure 7-D).

The grader operator will not be required to dispose of the contaminated surface material. However, such disposal is a necessary part of the decontamination operation, and the dump site should be selected and prepared before the operation is begun. The site should be located in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time. The distance may be shortened by dumping the contaminant behind a natural or prepared barrier or into an excavated ditch, which will shield the cleared area. The dump site should be back-filled after decontamination is completed.

PROCEDURE

- a) After dump site has been selected and prepared, set blade at maximum angle for right hand (or left hand) windrow.
- b) Set blade pitch for minimum top and bottom spillage.
- c) Set blade for depth of cut desired, at least two inches.
- d) Spray surface with water if soil is dry and dusty.
- e) Begin operation along right hand (or left hand) edge of area. Select long dimension edge, to minimize number of turn-arounds and windrows.
- f) Collect windrow material and haul to dump site by method selected.
- g) Clean up "hot spots" by manual shovel and wheelbarrow.
- h) Backfill dump site.

RATE OF OPERATION

The motor grader should advance at between one and one half and three miles per hour, depending upon surface conditions in the area, amount and size of rocks, obstructions, grade, etc.

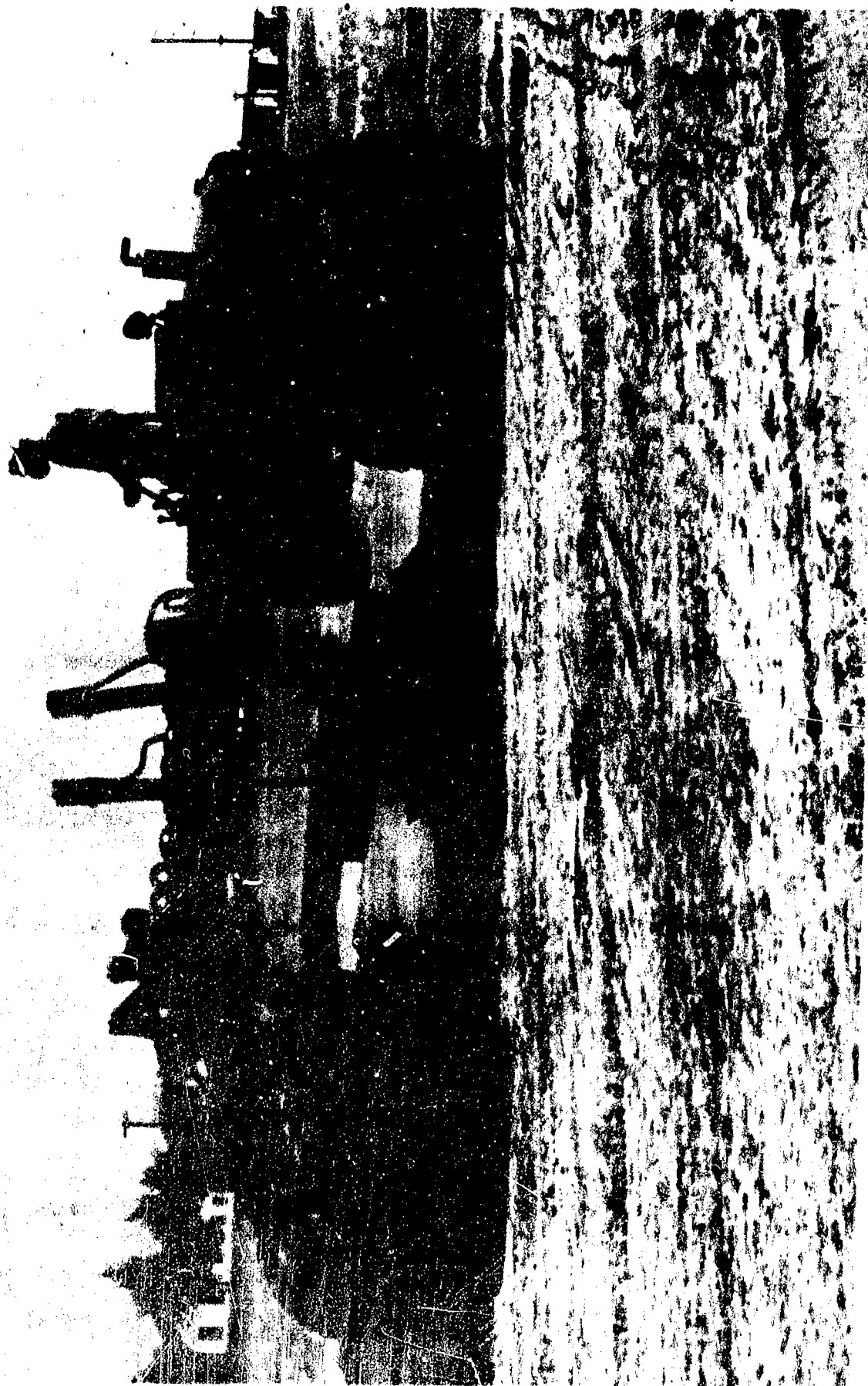


FIGURE 7-G MOTOR GRADER

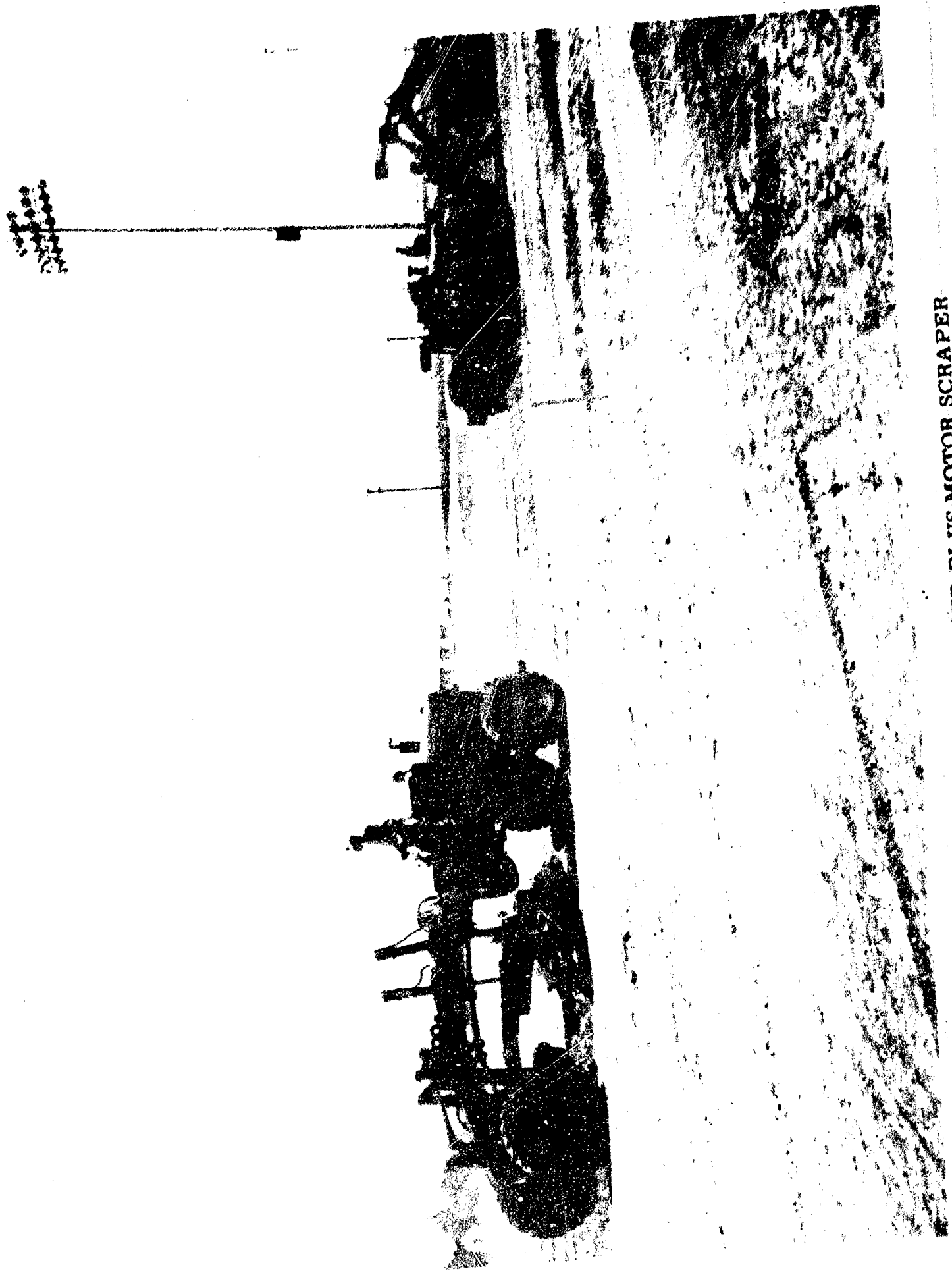


FIGURE 7-H MOTOR GRADER PLUS MOTOR SCRAPER



FIGURE 7-1 FRONT END LOADER

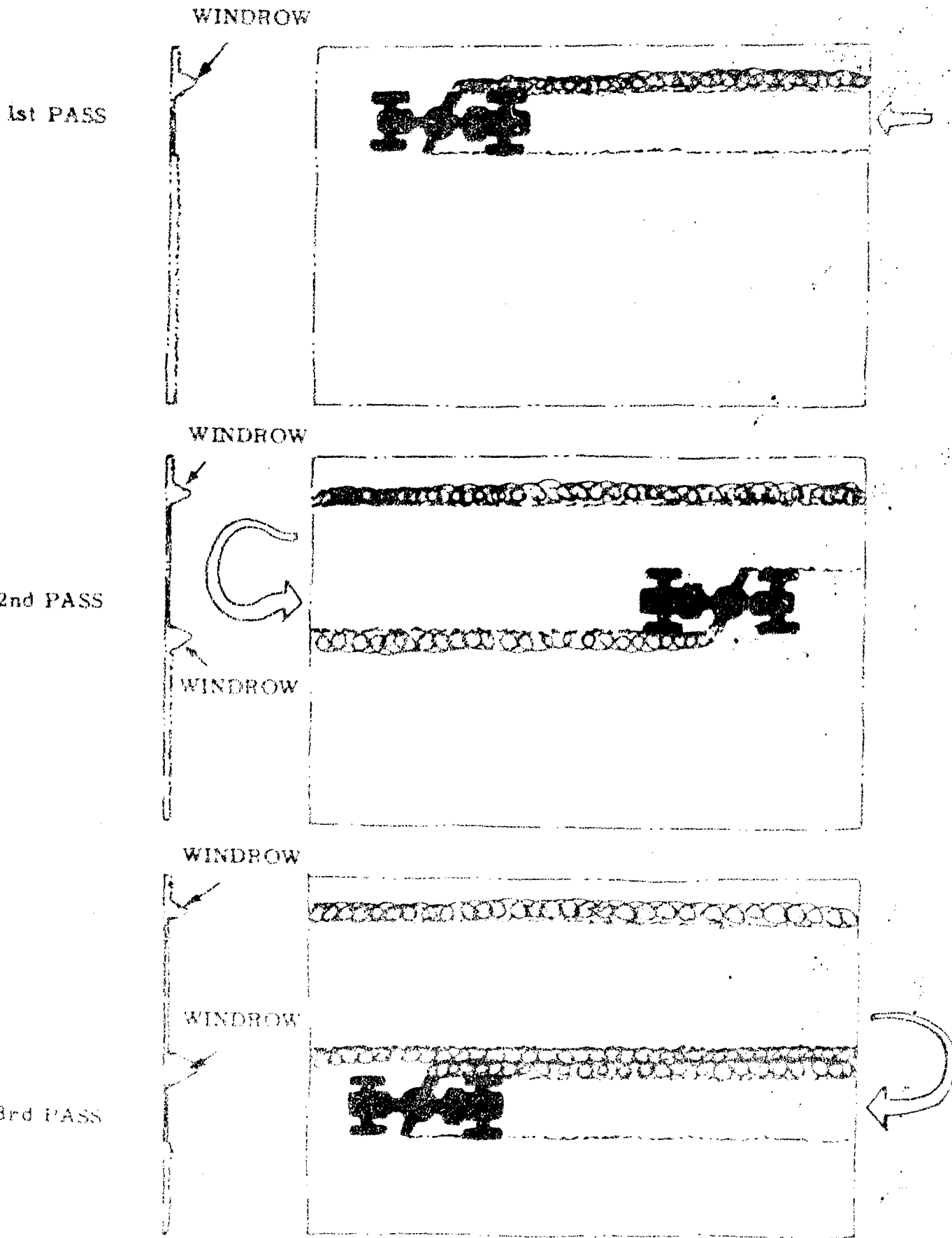


FIGURE 1-11 PROCEDURE FOR USING MOTOR GRADER

BULLDOZER

Page 1 of 3

May, 1964

MANPOWER

Bulldozing is a one man operation. However, additional workers will be needed for operating a motor scraper, front end loader and truck, or other pick-up and hauling machinery.

EQUIPMENT

One or more track-type bulldozers, with the widest available blades, are required for these decontamination methods. Other equipment, for picking-up and hauling contaminant to the dump site are also required.

PRINCIPLE OF OPERATION

A bulldozer (Figure 7-K) operates by its tractor moving forward while its blade raises or lowers to cut, spread, or transport soil or other loose material. As a dozer advances and digs, some of the soil cut by the blade will pile up in front and move along with it. Some material will drift off the sides, forming ridges or windrows.

Resistance to forward movement of the machine is the result of the work needed to cut and break up the soil and to push it along. With the blade set for a constant depth of cut, resistance to digging will remain approximately even throughout a pass. However, the total resistance force will rise steadily as the amount of cut soil in front of the blade increases. For this reason, bulldozers are limited to clearing small areas, with passes of not over 100 feet. The relatively small size of bulldozers make them particularly suitable for use in confined spaces.

Side spillage of contaminated soil or snow may be reduced by operating two or more bulldozers at once, one slightly in advance of the other, with the latter's blade overlapping the path of the first machine. In this way, only the outer ends of the outer blades will form windrows.

Since bulldozers are not well suited for moving large quantities of material for long distances, they can be operated effectively in combination with scrapers or loaders and trucks, in the same way that motor graders are used. (See previous section.)

In addition to decontaminating areas for occupation, bulldozers can be utilized very efficiently in covering Buffer Zone surfaces with uncontaminated fill. A covering of six to eighteen inches of fill should be applied evenly over the surface. While this will not provide much shielding for persons standing in the Buffer Zone, it will give several feet of oblique shielding to the cleared areas near the Buffer Zone. (See Chapter 4, Section 4.2)

The bulldozer cannot procure and haul the fill material, but it is especially effective for spreading fill material over the surface, once trucks or other hauling vehicles have delivered it to the area. It can also be used effectively for stripping the contaminated top layer of soil at the site where the clean fill will be procured and for digging up the fill material into piles, for loading into trucks.

Experiments have shown that Buffer Zones can be greatly reduced in width by the creation of perimeter earth barriers. The top two or three inches of soil is

PRINCIPLE OF OPERATION (continued)

first pushed to beyond the edge of the desired zone. The bulldozer then takes a deep cut into the exposed clean earth and pushes it to the zone edge, creating an "earth dike" wide enough and high enough to act as an effective shield against the fallout radiation beyond. Dike proportions should be great enough to shield personnel from line-of-sight exposure to the fallout. (Figure 7-L)

Bulldozers can be used effectively for "hot spot" clean-up, but some manual shoveling may be required if the area has many obstructions which cannot be removed.

GENERAL INSTRUCTIONS

Although the bulldozer operator will not be required to move contaminated material to a dump site, such a site should be selected and prepared before decontamination is begun. The bulldozer will be the best piece of equipment to use in its preparation.

The dump site should be located in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time. The distance may be shortened by dumping the contaminated material behind a natural or prepared barrier or into an excavated ditch, which will shield the cleared area. After the decontamination operation is complete, the dump site should be backfilled.

PROCEDURE

1. Prepare dump site.
2. Sprinkle area with water if the surface is very dry and dusty.
3. Clear surface to a minimum depth of four inches, to avoid missing low spots. Depth of cut in snow is dependent on location of fallout particles. (See Chapter 5, Section 5.5).
4. Work across narrow dimension of area, to avoid long runs that will cause excessive spillage around and over the blade.
5. If the narrow dimension is over 100 feet, push from the middle out to one edge, overlapping to pick up spillage from the previous pass.
6. After completing one side, push from the middle to the opposite edge.
7. After completing main clearing operation, make clean-up passes to push windrows to one side of area.
8. Clean up major "hot spots" with bulldozer. If small contaminated spots remain around immovable obstructions, they should be cleaned with shovel and wheelbarrow.
9. After contaminated material has been hauled to the dump area, backfill to avoid possibility of radioactive dust blowing over cleared area.

RATE OF OPERATION

The bulldozer should advance at between one and three miles per hour, depending upon soil condition, surface rocks, depth of cut desired, etc.

PROCEDURE

1. After dump site has been selected and prepared, start operation along upwind, long side of area.
2. Adjust blade height, if possible, to cut below contaminated depth of snow. (See Chapter 4, Section 4.2).
3. Follow pass pattern shown in Figure 7-P.
4. Push windrows to edge of area for pick-up, if this disposal procedure is to be used.
5. Remove "hot spots" by snow plow, bulldozer, or shovel and wheelbarrows.

RATE OF OPERATION

The snow plow should advance at between two and five miles per hour for fairly heavy falls of undisturbed snow, and faster for shallow depths. The rate will be slower for snow which has been trampled down or crusted. Over rough and steeply sloped terrain the operating rate may be still slower.

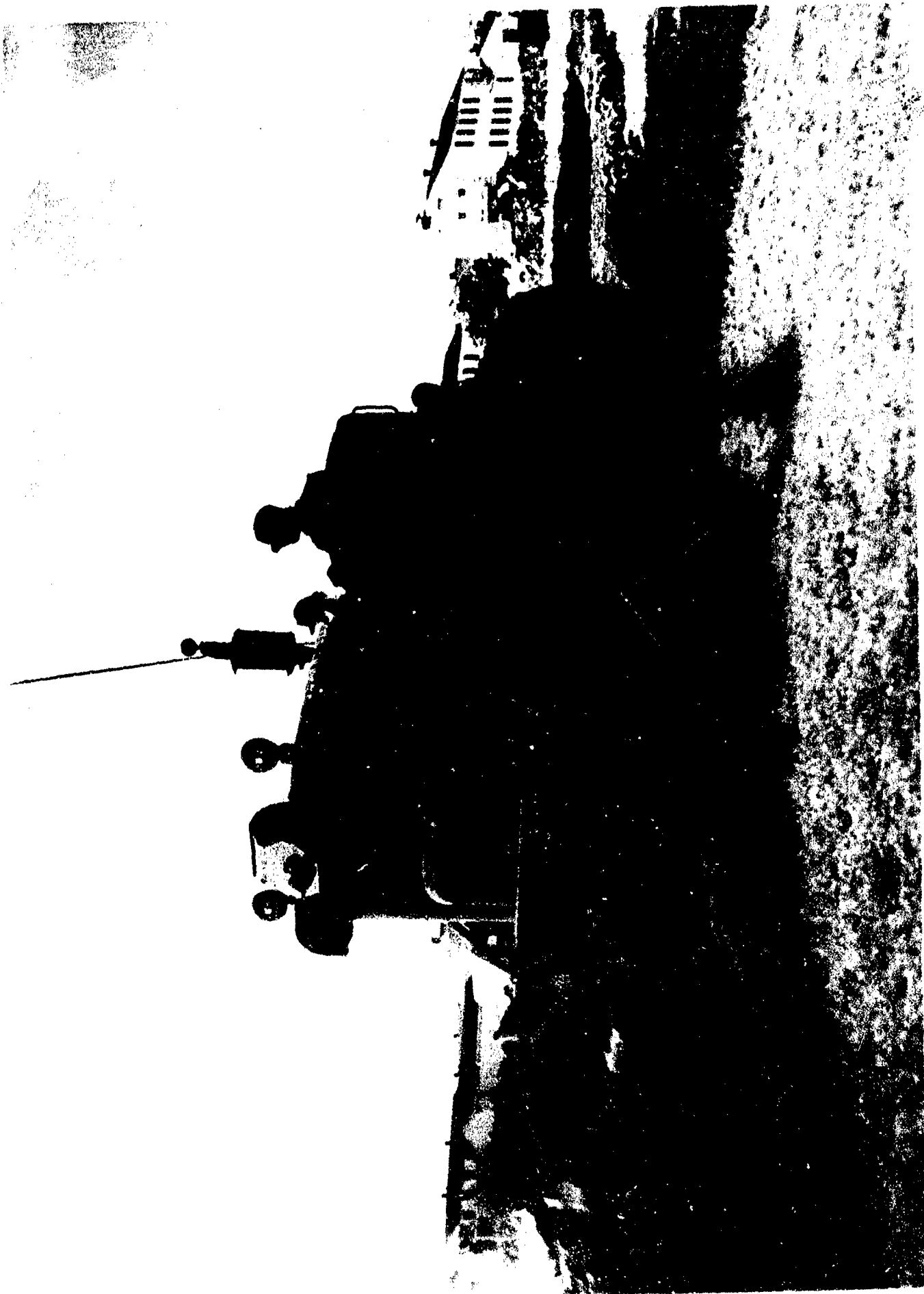


FIGURE 7K BULLDOZING

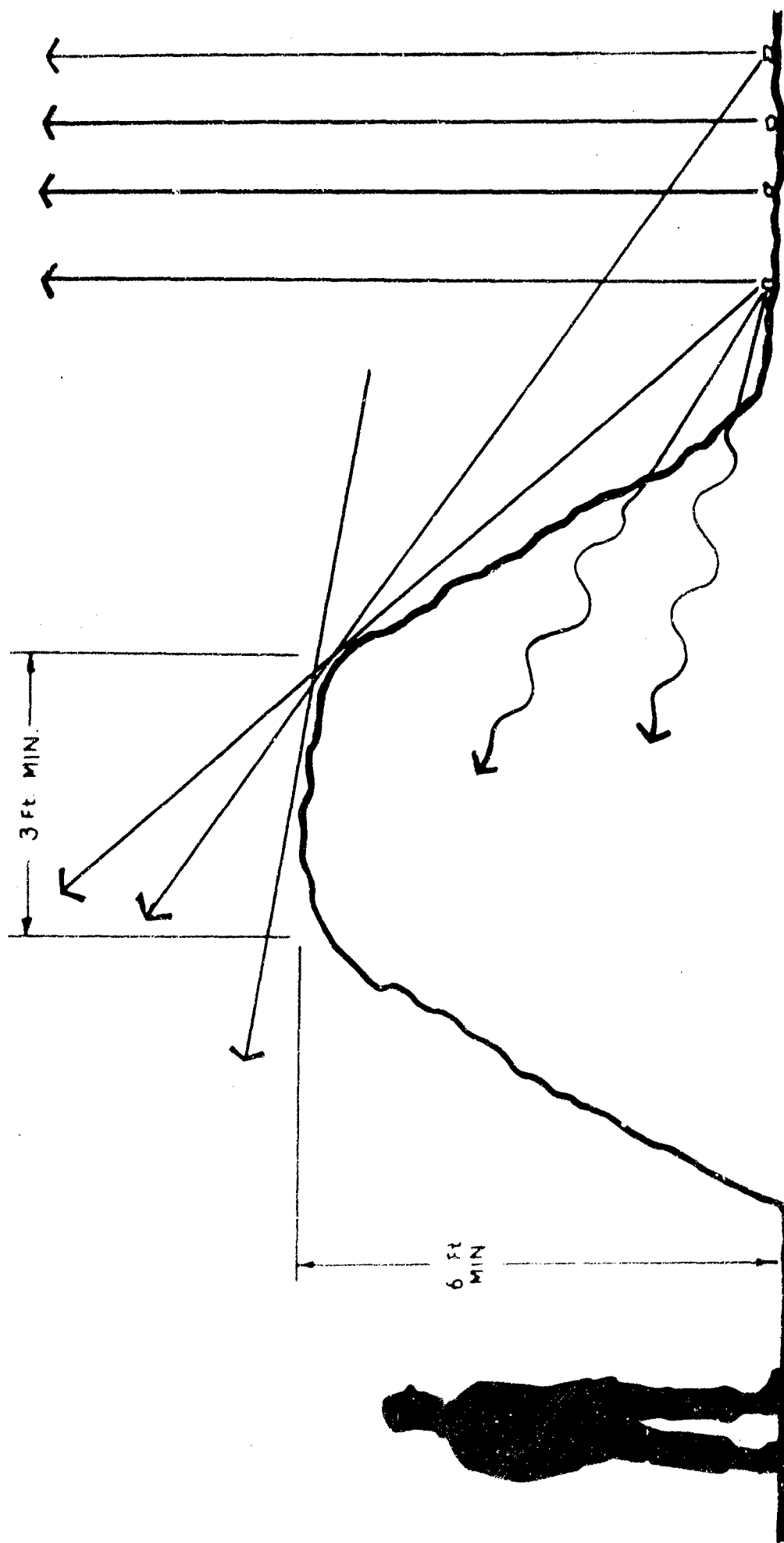


FIGURE 7-L
EARTH DIKES SHIELD EDGES
OF DECONTAMINATED AREAS
FROM FALLOUT RADIATION

RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES		NEW DECONTAMINATION METHODS	
FLOWING		Page 1 of 1	May, 1964
<p><u>MANPOWER</u></p> <p>One operator is required to decontaminate natural areas by this method.</p>			
<p><u>EQUIPMENT</u></p> <p>A plow, preferably one having three plowshares, and a tractor to pull it are required. To obtain the maximum depth of turnover, a tractor of sufficient power should be used, not less than 125 horsepower for a three share plow.</p>			
<p><u>PRINCIPLE OF OPERATION</u></p> <p>Plows turn the surface soil under but do not remove it. When land is plowed, the soil is lifted along the spiral of the plowshare, rolled 180°, and dropped into the adjacent furrow created by the previous parallel pass. (Figure 7-M) The larger the plow, the deeper the burial of the surface soil - usually six to ten inches.</p> <p>Plowing an unpaved fallout covered surface is a rapid process, free of waste disposal problems. Although a few inches of soil do not provide much shielding for persons standing directly above, they give several feet of oblique shielding to areas nearby. (See Figure 4-D) Plowing therefore is acceptable for Buffer Zone preparation, around the edges of decontaminated areas.</p> <p>Plowing is not satisfactory, however, for areas to be occupied by personnel. Besides furnishing an insufficient shield, the turned-over earth is rough and difficult to walk or ride on. (See Figure 7-M) Heavy traffic will tend to stir up the loose soil, causing the buried fallout particles to return to the surface.</p> <p>Unlike surface removal methods such as scraping and grading, multiple passes with the plow do not increase the thoroughness of decontamination. On the contrary, a second pass will return a large proportion of the fallout particles to the surface. Plowing, however, after surface removal by one of the other methods, can decrease the remaining radiation by providing surface shielding.</p>			
<p><u>PROCEDURE</u></p> <ol style="list-style-type: none"> 1. When the surface is very dry and dusty, spray with water, if possible. 2. Plow in parallel passes, either back and forth, or around the area, spiralling in or out on each pass. 3. Do not plow over any surface which has previously been plowed for decontamination. 			
<p><u>RATE OF OPERATION</u></p> <p>The plow should advance at approximately 1-1/2 miles per hour. This rate will vary, however, depending on the character and condition of the surface, the presence of rocks, vegetation, etc.</p>			



FIGURE 7-M PLOWING



FIGURE 7-N RESULT OF PLOWING

RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES	DRY DECONTAMINATION METHODS	
SNOW PLOWING	Page 1 of 2	May 1964

MANPOWER

Snow plow operation (Figure 7-0) requires one man. However, since snow plows cannot dispose of the contaminated snow, other personnel operating other types of equipment will be required.

EQUIPMENT

Any available truck or tractor mounted snow plow can be used. For large areas and deep snow, large bladed plows with wings will clear fastest. Plows with "V" blades are especially suitable for very deep drifts as the two sided blades balance side thrust on the vehicles.

PRINCIPLE OF OPERATION

Snow plows provide by far the fastest means of any of the decontamination methods for removing snow from flat or moderately sloped surfaces.

Snow plows move material by the process of side casting. The snow slides off of the angled blade into a windrow as the plow advances. Some plows have "V" shaped blades angling to both sides, and therefore, form two windrows.

By straightening the blade angle, snow plows can be used to push the windrows to the edge of the area being cleared, providing that the length of push is not so great as to cause spillage around and over the blade. Because snow plows do not pick up and haul loose material, other means must be employed to move the contaminated snow to the dump site. Windrows can be pushed to the edge of the area by snow plow or bulldozer for bucket loading into a truck and removal to a dump site; or they can be picked up in the area and hauled away, by scraper or front end loader and truck.

GENERAL INSTRUCTIONS

Snow plows which throw windrows to one side only should follow the pattern shown in Figure 7-P. Operation should proceed back and forth along the long dimension of the area, starting on the windward side, if possible. With the blade angled for a windrow on the right, snow removal should start along the right hand side of the area. The second pass should be parallel to the first, in the opposite direction, and slightly overlapping it. The windrow will again be thrown to the right, but from the opposite direction. The third pass should be made in the original direction, and the windrow thrown against that made on the second pass. The cleared spaces between windrows will thus be approximately two snow plow widths.

Snow plows with "V" blades which throw windrows to both sides, should work back and forth spacing their passes so that one plow width of cleared space between windrows will result.

Although the snow plow operator will not be required to move contaminated snow to a dump site, such a site should be selected and prepared before decontamination is begun. The dump site should be selected in an area which will not require subsequent decontamination. It should be downwind, if possible, and the shortest safe distance away, to minimize travel time. The distance may be shortened by dumping the contaminated snow behind a natural or prepared barrier or into an excavated ditch, which will shield the cleared area.

PROCEDURE

1. After dump site has been selected and prepared, start operation along upwind, long side of area.
2. Adjust blade height, if possible, to cut below contaminated depth of snow. (See Chapter 4, Section 4.2).
3. Follow pass pattern shown in Figure 7-3.
4. Push windrows to edge of area for pick-up, if this disposal procedure is to be used.
5. Remove "hot spots" by snow plow, bulldozer, or shovel and wheelbarrows.

RATE OF OPERATION

The snow plow should advance at between two and five miles per hour for fairly heavy falls of undisturbed snow, and faster for shallow depths. The rate will be slower for snow which has been trampled down or crusted. Over rough and steeply sloped terrain the operating rate may be still slower.

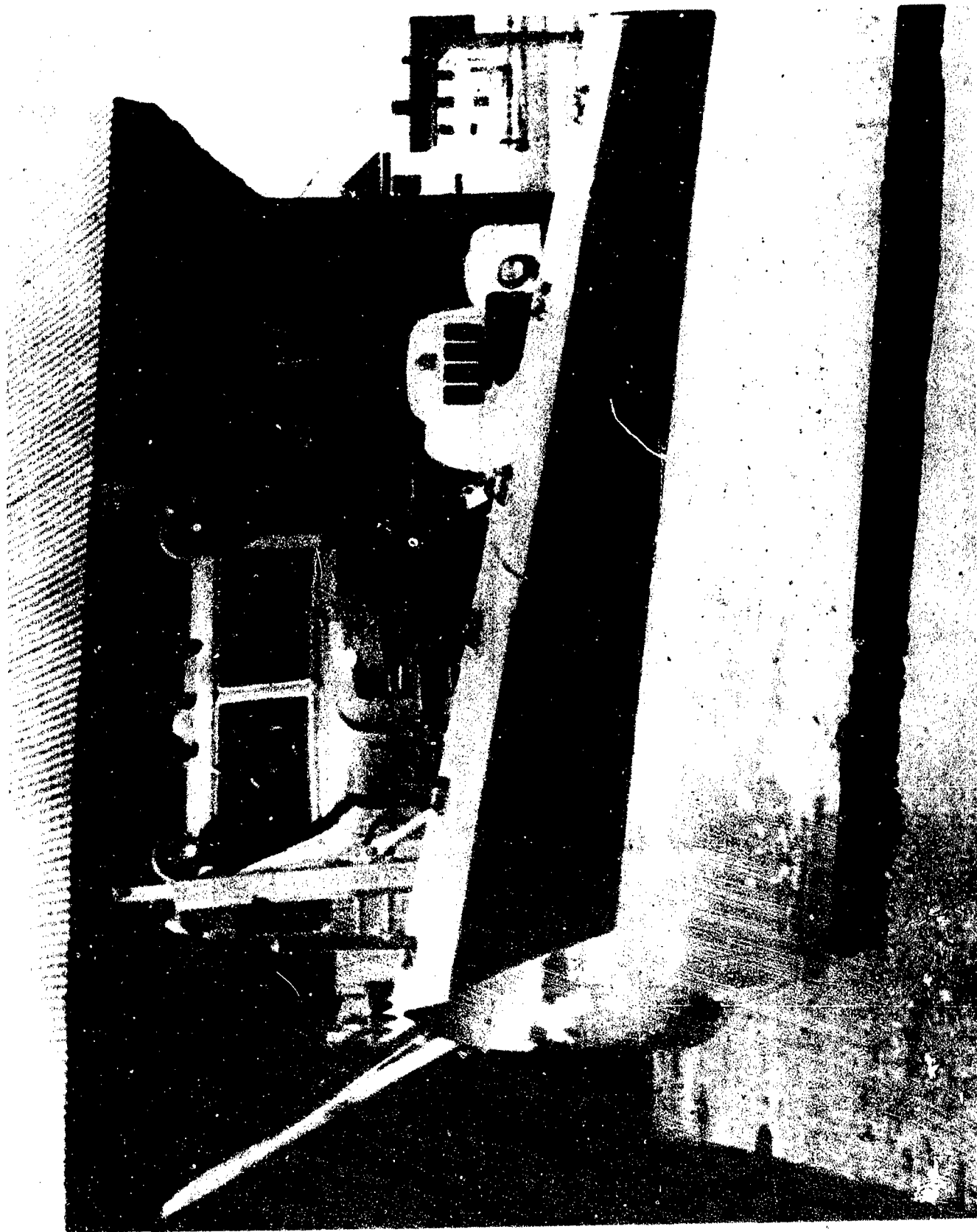


FIGURE 7-0 BLADE SNOW PLOW

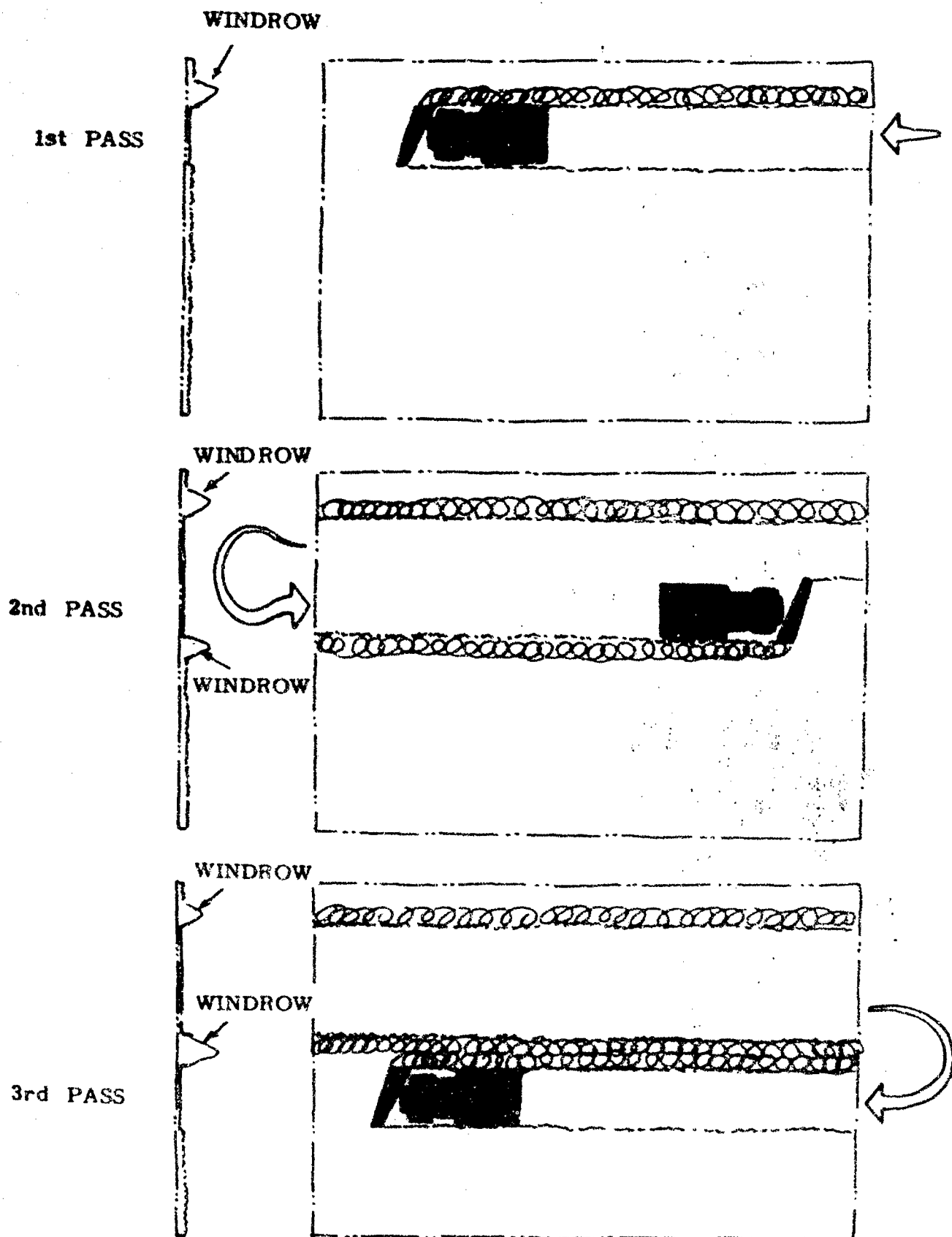


FIGURE 7-P

PROCEDURE FOR USING THE SNOW PLOW
(COLD WEATHER)

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